Treatment of the Sandal Tree.

BY SIR DIETRICH BRANDIS, K.C.I.E., F.R.S.

MR. BARBER's paper on the sandal tree in the *Indian Forester* of September last has interested me. That this tree is a root parasite was established in 1871 by the late John Scott, then Curator of the Royal Botanical Garden, Calcutta, in a most important paper on *Loranthaceæ* and other parasites. (Journal of the Agricultural and Horticultural Society, Calcutta, Vol. II, p. 287). This paper has not received the attention in England which it deserved. Mr. Barber himself apparently had not seen it when he wrote. In other countries, however, it has been fully appreciated. Count Solms Laubach, who in 1867 had published his researches on *Thesium* and *Osyris*, both root parasites of the Order *Santalaceæ*,* gave in the *Botaniche Zeitung* for 1874 (pp. 128 and 144) a full account of Scott's paper, including a translation of that portion which relates to *Santalum*. The microscopic examination by Count Solms Laubach of Sandal haustoria sent him by Mr. Scott, whereby its roots attach themselves to the roots of other plants, showed a structure in all essential points identical with that of the haustoria of *Thesium*. In Engler und Prantl Natürliche Pflanzenfamilien (*Santalcaeæ*) III. 1. 204, and in the article on *Santalum album* of Köhler's Medizinalpflanzen (Vol. III) a detailed review of Scott's researches will be found. In 1872 and 1873, when I was working at Kew on the Forest Flora of North-West and Central India, Scott's paper of 1871 was not known to me, and the reviews mentioned above appeared much later.

It will interest the readers of this paper, that Charles Darwin had a very high opinion of John Scott's scientific work, while he was a gardener at the Edinburgh Botanical Gardens, before going out to India. (Letter to Asa Gray, December 1861, in *Life and Letters of Charles Darwin*, III, 300.)

Scott established the root connection between *Santalum album* and species of *Saccharum*, *Bambusa*, as well as a number of palms. To palms he paid special attention, because he had noticed sandal trees growing with unusual vigour in the vicinity of *Arenga*. Among Dicotyledons he examined the root connection with two species of *Heptapleurum* and *Inga dulcis*.

In regard to *Heptapleurum*, the following extract from Mr. Scott's paper is worth quoting here:—

"With the *Araliaceæ* I had most demonstrative evidence: first in a vigorous old tree of sandalwood growing in the vicinity of a large specimen of *Heptapleurum umbraculiferum*, which I had occasion to cut out. A few months after this I was surprised to find the tree nearly destitute of leaves and altogether in a most unhealthy state, though for some time, after the ivy wort had been

* Hermann graf zu Solms Laubach, Bau und Entwicklung parasitischer Phanerogamen, in Pringsheim Jahrbücher für wissenschaftliche Botanik VI. 539.

removed, no changes had been observed. This, however, was probably due to the strong vitality of the ivy wort's roots, which may have remained fresh for weeks after the stems had been cut out. The tree has since made poor and weak growths, though always yielding an abundance of flowers; and now—the fourth year—it seems to be acquiring fresh vigour, probably from having formed new root attachments. The *second* case was of a young tree, 15 feet in height, and growing from the midst of a bush of *Heptapleurum venulosum*. The latter having been cut out, the young sandalwood tree shortly after lost the whole of its foliage and was for fully two years afterwards in a most unhealthy state."

If I correctly understand Mr. Barber, he has established the root connection of *Santalum* with *Casuarina* and *Lantana*. Hence it is evident that the sandal tree lives and thrives while its roots are in intimate connection with the roots of many other plants belonging to different orders and having different structure and organization. Foresters in Mysore and Coorg have long known by actual experience, that the tree thrives well when growing in company with *Casuarina* and *Lantana*. But they have also known that it flourishes when growing in hedges and among shrubs where no *Casuarina* or *Lantana* is near.

The sandal tree most probably takes up a large proportion of those mineral substances which it requires, not directly from the soil, but through its haustoria from the roots of those plants with which it lives. It is well known that plants do not take up indiscriminately all substances which are offered to their roots in a soluble state, they have the power of selecting those substances which suit them best. The majority of trees and shrubs, for instance, leave soda salts alone and take up instead potassium salts from the soil. The coffee bush takes up a large proportion of magnesia, the bamboos take up enormous quantities of silica, and tobacco extracts lithium from soil, in which this element is present in the most minute quantities. Doubtless, therefore, there are only certain species which are capable of furnishing those mineral salts which sandalwood requires. But we have seen that these species are very numerous, and that they belong to a large number of different natural families.

It is also probable that the sandal is not wholly dependent upon its companions for the supply of the mineral salts it requires. Some root parasites, I believe, are entirely without those fine hairs on the last ramifications of the roots which, by attaching themselves firmly to the minute particles of the soil, with the aid in many cases of acids secreted by them, take up mineral substances from the soil. It will be important to ascertain whether *Santalum album* has effective root hairs or not, for on this fact depends the question, to what extent the tree has to rely upon its companions for part of its nourishment.

Mr. Barber's communication is, I trust, the forerunner of important publications regarding this subject. He is familiar with the methods of anatomical and physiological research, and though the fact of the root union of the sandal tree with numerous species has been established beyond doubt, many questions remain to be solved. On the present occasion I would mention two questions of great practical importance: *First,* has the tree effective root hairs, and is it capable of taking up directly from the soil a portion of the food it requires? *Second* which species are the most useful companions of the sandalwood?

Readers of this paper will doubtless be struck by the fact that *Casuarina equisetifolia* is not a native of the Western Peninsula, and that *Santalum album* only made the acquaintance of its present useful companion about 30 or 40 years ago. The experience of the plantations near Bangalore show, I understand, that the union with this species is most beneficial to the sandal tree. On the Nilgiris in 1882, chiefly near Coonoor, the woods of *Acacia melanoxylon* were attacked on a large scale by Indian species of *Loranthus*, whose acquaintance the Australian *Acacia* had not previously made. In this case however the *Loranthus* did serious injury to the *Acacia*,—it killed many trees I believe.

In the plantations near Bangalore, Mr. Pigot informs me that the *Casuarina* trees all die off together, when aged about 25 years, and that fears are entertained for the sandal after the loss of its companion. An underwood of *Lantana* might be tried, but apparently it is feared that it may prove a dangerous friend, that it may outgrow the sandal and smother it. There would not, however I suppose, be any difficulty if matters are methodically managed, in periodically cutting back the *Lantana* and thus compelling it to grow as underwood under the sandal trees.

If my memory does not fail me, *Cassia auriculata (Tangedu)* is frequently found associated with sandal in Mysore and Coorg. *If so, experiments should be made to sow the two together.* This species of *Cassia* is a valuable plant, hence I mention it. Also the seed of other shrubs or trees found in places where sandalwood grows should be sown with it experimentally. Foresters in Mysore, Coorg and adjoining districts of the Madras and Bombay Presidencies will know how to make these experiments. One point is important,—such experiments must be under uninterrupted control by a competent and intelligent Forester. Hence they must be made in a garden or in a forest nursery. Provided these experiments are continued steadily with system and method, they will show in a few years which companions suit the sandalwood best, and then I fully anticipate that the progress of sandal plantations will be steady and satisfactory. Misfortunes, such as the spike disease, will always happen, but the spruce and pine forests of Germany continue to flourish in spite of the ravages of the *Nun* and of *Gastropacha Pini.*

Like the oak, the larch and other trees, which require much light, the sandal thrives best when the ground is covered by a dense underwood, and the fact of its being a root parasite makes such underwood a necessity. But it must have room to develop a crown, and that crown must be exposed to the light. These facts, I believe, are now universally acknowledged, and if they are steadily borne in mind by those who have to cultivate this important tree, the result doubtless will be favourable.

By self-sown seedlings the sandal tree propagates itself so readily that all the present trouble might have been avoided if a sufficient area of sandalwood bearing tracts had been set aside as Reserved Forest and had been efficiently protected against fire and grazing. Many years ago, I well remember, this plan was strongly advocated by the Government of India. However, as far as I know, no action except on a very small scale was taken in this direction by the local authorities. Under these circumstances there is no help for it, sandalwood must now be raised by sowing and planting on a large scale.

The Insect World in an Indian Forest.

By E. P. Stebbing, F.L.S., F.E.S.

(*Continued from Vol. XXVIII, p.* (431.)

Part III.

Order III.—*HYMENOPTERA.*

In the adult insect there are four membranous wings present, which have no scales upon them, are usually transparent and never very large, the hinder pair being smaller than the front ones; the cells formed by the nervures, in the wing are irregular in size and form and never very numerous (less than twenty on the front, than fifteen on the hind wing). Mandibles are conspicuous even when the other parts of the mouth form a proboscis or sucking tube. The females are furnished at the extremity of the body with either a saw, sting, or ovipositor; these parts may be either withdrawn into the body or may be permanently protruded. Metamorphosis is complete. In the pupal stage the parts of the perfect insect are seen nearly free, each covered with a very delicate skin.

The Order *Hymenoptera* includes the wood-wasps, saw-flies and gall-flies; the numerous tribes of the Ichneumon flies and Chalcid flies and the ants, bees, and wasps. It is a large Order, in which a very large number of species remain to be discovered and described, and this is especially the case in India. In the adult insect the head is short and broad and deeply constricted off from the prothorax and never sunk into it; sometimes it is attached to this latter by a stalk-like process. The mandibles are powerful biting organs and the proboscis is at times of some length, it being used for sucking up sweet liquids

into the mouth. The prothorax is but feebly developed, the dorsal portion being separated from the ventral half, the former being firmly fused to the mesothorax, whilst the lower portion (with the first pair of legs) is movable. Meso- and meta-thorax are usually immovably united, but in the saw-flies and wood-wasps they are freely movable. The legs have large coxæ and the trochanter is often divided into two joints (in the *Tenthredinidæ*, *Uroceridæ*, *Cynipidæ* and *Ichneumonidæ*); the tarsus is five-jointed, the first joint being longer than the following ones. The upper and lower wings are connected by a row of small hooks which fix on to the stout curved edge of the front wing, the two wings on one side thus acting as one piece. In all but the *Tenthredinidæ* and *Uroceridæ* there is a deep constriction between what appears to be the thorax and the body.* The abdomen is thus said to be *stalked*. The eggs when being laid pass through the hollow stabbing or boring apparatus at the end of the body of the female, in many cases a prick or cut being made in an animal or plant with this instrument for the reception of the egg. This apparatus may also serve as a sting (*e.g.* in the wasp). The grubs are usually white in colour and blind; only in the *Tenthredinidæ* and the *Uroceridæ* do they resemble the caterpillars of the *Lepidoptera* (butterflies and moths). The larvæ often form cocoons to pupate in. One of the most remarkable facts connected with this Order is the prevalence of parthenogenesis (or the production of young by the female without the concurrence of the male) in a considerable number of widely separated species. In some members of the Order it is believed that the reproduction is entirely parthenogenetic. In the gall making *Cynipidæ* parthenogenesis is frequently accompanied by alternation of generations, a generation consisting of two sexes being followed by another consisting entirely of females, which in its turn gives rise to a bi-sexual generation.

This Order consists of two very distinct Sub-orders dependant upon the manner in which the abdomen is joined on to the thorax, *viz* :—

I.—*Hymenoptera Sessiliventres.*—Insects with the abdomen broad at the base, its first segment not completely joined to the thorax.

II.—*Hymenoptera Petiolata.*—The abdomen connected with what appears to be the thorax by the slender joint forming a marked constriction between the apparent thorax and the abdomen.

I.—Hymenoptera Sessiliventres.

The abdomen is not stalked but is nearly continuous in outline with the thorax. Trochanters are divided into two portions.

* This constriction really occurs in the first abdominal segment and not in the thorax. This first abdominal segment is firmly fixed to the thorax, and the constriction occurs between it and the second segment of the body.

The saws or boring apparatus at the end of the body of the female are concealed or only just visible. The larva has three pairs of thoracic legs and often numerous abdominal ones. The food is vegetable, some species feeding in galls on plants, others in the interior of twigs, whilst others again bore into and live in the hard wood of trees and shrubs. The majority, however, live upon the leaves of plants. Those which live in wood resemble coleopterous larvæ in appearance, whilst the species living and feeding upon leaves resemble the leaf eating lepidopterous caterpillars.

FAMILY CEPHIDÆ (THE STEM SAW-FLIES).

Slender insects with a weak integument and slender antennæ. The female bears a saw at the end of her body. The larvæ live in the stems of plants or in the tender shoots of trees and shrubs.

Little is known about these insects in India. One, however,—an unknown species—has been found boring into the bases of the young new needles of the deodar in the spring. The needles develop on the branches in small rosettes, and if these be examined when attacked by this minute insect, they will be seen to have swollen up at their bases in such a manner that the needles coalesce at the bottom. A closer examination shows that the swelling is convex on the outside, concave on the inner one, and in this small concave elliptical depression a tiny orange grub will be found. This is the larva of this small cephid. The irritation set up by its feeding operations causes the swelling at the base of the needle, and from four to six weeks are spent in this stage of its existence. The pupal stage is a short one, and about the middle of June or beginning of July the tiny brilliant metallic blue flies issue. The length of this insect is $\frac{1}{18}$th of an inch only. The attacked rosettes turn yellow and die, and occasionally a considerable amount of defoliation is accomplished in this manner on young saplings.

FAMILY SIRICIDÆ OR UROCERIDÆ (WOOD-WASPS).

Large insects of bright conspicuous colours; the female is provided at the extremity of the body with an elongate, cylindrical, boring instrument. Antennæ are filiform and elongate; the abdomen has eight dorsal plates, and the tibia of the front leg is provided with a spur; the anal lobe of the posterior wing is large. The larvæ live in wood, in which they gnaw long winding passages; they are blind yellowish-white grubs, with three pairs of short thoracic legs, but have no abdominal legs.

Until the present year our Indian Forest *Siricidæ* were unknown. The life-history of a *Sirex* sp., a magnificent insect not unlike the well-known and oft-quoted *Sirex gigas* of Europe, has been recently discovered and partially worked out by the writer and will be described shortly here.*

* For a fuller account see 'Departmental Notes on Insects that affect Forestry,' No. 2, p. 151, and plate VII.

Sirex sp. is a large handsome insect, the general colouring of the male being a deep metallic blue, green, and rich chestnut, the wings having a coppery sheen on them. The female is a deep metallic green on its upper surface. The grub is stout, thick, canary yellow in colour and about 1½ inches in length. The pupa is unenclosed in any cocoon, being pale yellow in colour.

The female lays her eggs in the wood of dead spruce (*Picea Morinda*, Link. in the North-west Himalayas, drilling holes into the tree by means of the auger and drilling apparatus at the end of her body. The larvæ on hatching out bore winding galleries in the wood, these galleries having no apparent definite direction. The grubs evidently spend more than a year thus boring in wood, larvæ of various sizes being obtainable at any time. The larval tunnels are tightly packed with the wood sawdust passed through the body of the boring insects. When full fed the larvæ change to pupæ at the end of their tunnels with no special preparation, and the pupa is thus found lying naked at the end of the boring, the only free space unblocked with wood refuse in which is that occupied by it. The larvæ pupate about June, and fully developed imagos emerge in July. When ready to leave the tree the mature sirex bores its way out by a circular boring, an eighth of an inch in diameter, drilled in the wood by means of its powerful mandibles, and it invariably chooses the shortest route to the outside, the gallery having, however, usually a slight upward direction.*

This insect is capable of doing the most serious injury to timber, as the winding galleries of the larva and the exit holes of the mature insect riddle the wood and make it useless for anything save firewood. Further study of the habits of this insect may show that it attacks other coniferous trees.

Two, if not three, as yet undescribed and unnamed species of the wood-boring *Xyphidriides* which belong to this family have also been recently found boring into spruce in a manner very similar to that pertainable to the sirex. They are not unlike the latter, but can be recognised by having an exserted head, the latter being separated from the thorax by a well-marked neck. They are also smaller.

FAMILY TENTHREDINIDÆ (SAW-FLIES).

This is an important family, but little is known about its members in India and practically nothing about their habits. The perfect insects have a superficial resemblance to a large blue bottle fly, but can be distinguished by having the four wings instead of two; there are no spurs on the front tibiæ of the legs. The larvæ are very like caterpillars, having three pairs of thoracic

* *Vide* a note on the habits of the larvæ and adults of *Sirex* and *Thalessa* by the author in *Nature* of August 21st, 1902.

legs and six to eight pairs of abdominal ones; in this they differ from lepidopterous caterpillars, which never have more than five pairs of abdominal legs. Saw-fly larvæ feed exposed on the leaves of plants in the same way as caterpillars, or they may live in galls, etc.

I have said that the life-histories of these insects have been very little studied in India until recently, but one or two crop-feeding forms being known. Within the last year, however, three species, as yet unnamed, have been found feeding upon coniferous trees in the North-west Himalayan forests. Of these one infests the deodar, a second the spruce, and the third the silver fir. Observations made on their habits show that they all feed upon the spring crop of needles of these trees, pupating some time in July. The larvæ are bright green in colour and about an inch or a little over in length. When feeding they take up a very characteristic position, which greatly aids in their recognition, for they coil the lower end of the body round the leaf upon which they are feeding. When full grown they change to pupæ within small light brown elliptical cocoons, the covering of which is of parchment-like consistency, which they attach to a needle. In the case of the silver fir saw-fly the larva pupates at the beginning of July, the mature fly issuing about the middle of the month. These coniferous saw-flies require careful study, as it is not improbable that they will play a not unimportant rôle in the forest as their management becomes more intense.

Almost every year a plague of green saw-flies make their appearance on rose bushes in the Dehra gardens and strip many bushes of their leaves. The cocoon formed is attached to the plant by a fairly long silken cord.

II.—Hymenoptera Petiolata.

The hind body is connected with the thorax by means of a deep constriction, so that there appears to be a stalk between it and the thorax. This stalk may be long or short, but is always present. This sub-order is divided into three series—

1. Parasitica or Terebrantia, including the families *Cynipidæ*, *Chalcidæ*, *Ichneumonidæ*, and *Braconidæ*.
2. Tubulifera—comprising the *Chrysididæ*.
3. Aculeata—including the families *Apidæ*, *Diploptera*, *Fossoria* and *Formicidæ*.

Series 1.—*Parasitica* or *Terebrantia*.

The trochanters (the second joint of the leg) are of two pieces, and the female is furnished with an ovipositor at the extremity of her body.

FAMILY CYNIPIDÆ (GALL-FLIES).

Small insects in which the abdomen is short and compressed, with an ovipositor arising from the ventral surface. The wings have only a few cells in them and have no stigma (a black patch) on the anterior margins of the upper wings. The antennæ are straight and are composed of a few (12—15) joints. The larvæ live in galls, either singly or several together. The female bores into the living portions of plants (stems, leaves, buds) by means of the spine at the end of the abdomen, and deposits an egg in the hole thus made; later on the plant tissue swells up in different ways owing to the irritation set up by the larva feeding upon the tissues. The different forms of gall thus arising are characteristic of different species of insect. In many species a regular alternation of a parthenogenetic and a true sexual generation exists, the two generations being dissimilar and causing galls of very different appearance.

Little is known about the life-histories of gall-flies in India, and the study of this interesting family greatly needs some energetic workers.

FAMILY CHALCIDIDÆ (CHALCID FLIES).

These differ from the last family in having elbowed antennæ consisting of from seven to thirteen joints. The wings are without a system of cells in them. The insects are frequently of brilliant colour, and remarkable form. They are mostly parasitic upon caterpillars, and have been reared from several forest defoliating caterpillars in India, and probably tend to keep these pests in check to some extent. Undetermined species of this family have recently been found parasitic upon the larvæ of *Polygraphus*, *Pityogenes*, and *Scolytus* bark boring beetles in Blue Pine and Deodar trees, and as our knowledge of these insects increases, it will doubtless be found that they are as beneficial in the forest as they are in agriculture.

FAMILY ICHNEUMONIDÆ (ICHNEUMON FLIES).

The ichneumons are insects with a long slender body and many-jointed antennæ. The wings have a well-developed series of nervures and cells in them. The female has usually a long protruding ovipositor. These insects are parasitic in their larval stages. The egg is deposited by the mother in the body of the caterpillar. The larva on hatching out is a little white legless grub, which feeds upon the fatty tissues of his host, the latter eventually dying of exhaustion, though it may have sufficient strength to turn into a pupa first. When full-fed the ichneumon spins itself up into a cocoon, which may be attached to the body of the dead caterpillar or may be free inside the pupal case of the host. It often happens that two or three eggs are laid upon the

caterpillar by the ichneumon fly and then several cocoons are obtained from the dead caterpillar or from the pupa into which it has changed.

This family thus performs a very important service in the forest by keeping down defoliating larvæ and wood boring pests and in fact insect pests of all kinds. At the same time it is also injurious to some extent owing to the fact that it also lays its eggs and kills off useful predaceous and parasitic insects.

The members of the genera *Rhyssa* and *Thalessa* are among the most remarkable of the Ichneumon flies. These insects have ovipositors of three to four inches in length, and are parasitic upon species of the family *Siricidæ* which, as above described, live in solid wood. The following is a note on a portion of the life-history* of an undetermined species of *Rhyssa* or *Thalessa* which is parasitic upon the *Sirex* sp. already described as infesting spruce in the North-western Himalayas. The mature insect appears on the wing about the beginning of June. The female is a fairly large handsome insect, black with yellow spots upon the thorax and a pink spot on either side of each segment of the body. The insect is one inch in length with an ovipositor of one and-a-half inches. Dead mature insects have been found in some numbers in spruce riddled by the *Sirex* sp., the tunnels in which the ichneumons were found communicating with the sirex larval ones in such a manner as to leave no doubt that the former was parasitic upon the latter. The larval and pupal stages of the ichneumon have not yet been found. There can be little doubt that this parasite is of the greatest service in keeping down the numbers of the sirex. It appears to itself suffer when the wood wasp larva has gone very deep into the wood, as the perfect ichneumon fly has then apparently not sufficient strength to bore its way out of the tree, and dies in the wood after having gone a certain distance.†

FAMILY BRACONIDÆ (BRACON FLIES).

These insects are very similar to the ichneumons. The antennæ consist of many (nearly always more than 15) joints, and the wings have a moderate number of cells in them. They can be distinguished from the ichneumons by the fact that the hind body has a much less degree of mobility of its segments and the upper wings differ, the series of cells running *across* the wing being only three in the Ichneumonides, whereas they are four in the Braconids, and a centre cell behind 2 and 3 is divided transversely

* *Vide* a note on 'The habits of the larvæ and adults of *Sirex* and *Thalessa*' by the author in *Nature* of August 21st, 1902.

† For a fuller account see 'Departmental Notes on Insects which affect Forestry' No. 2, p. 155, and plate VII, fig. 2.

into two in the former, but is undivided in the latter. If these distinguishing characters are remembered the two families can always be distinguished from one another.

The habits of this family are similar to the last, it being believed that they are nearly all parasites. Usually they attack larvæ, but they are bred in great numbers from pupæ and occasionally from imagos of other insects. The family requires careful study in India, where its members are probably of the very greatest service both in the forest and in the field. The writer has recently bred out bracon flies from two scolytid bark-boring pests—*Scolytus major*, M. S. and *S. minor*, M. S.—which infest deodar trees in the North-west Himalayas. The flies appear to lay their eggs in or on the larvæ of the scolytus.

SERIES 2.—*Hymenoptera Tubulifera.*

Trochanters undivided; the hind body consisting of from three to five visible segments; the female with an ovipositor, which is usually retracted and envelopes a fine pointed style. The larvæ usually live in the cells of other *Hymenoptera*. This is a small group in comparison with *Parasitica* and *Aculeata* and is not of importance here. One family is recognised.

FAMILY CHRYSIDIDÆ (RUBY WASPS).

Insects usually of glowing metallic colours, with a very hard, coarsely-sculptured integument; antennæ are abruptly elbowed. The abdomen is of peculiar construction and allows the insect to roll itself up into a ball.

SERIES 3.—*Hymenoptera Aculeata.*

Trochanters undivided; abdomen consisting of six or seven visible segments; female has a retractite sting. The bees, ants and wasps are included here.

FAMILY APIDÆ (BEES).

Usually very hairy insects, with elbowed antennæ; the parts of the mouth are elongated to form a protrusible proboscis; the tibiæ and tarsi of the hind legs are usually broad.

Some bees are social, *i.e.*, they form colonies of males, females, and winged workers, which are barren females. Other bees are solitary. In the social bees there is usually only a single fertile female in each nest, and when a new one is hatched the colony divides to form a new swarm. The bees build combs of wax arranged perpendicularly, consisting of layers of hexagonal horizontally-placed cells, closed at one end. The larvæ occupy some of these cells, whilst others are occupied by the workers or used as storage cells for honey and pollen. The queen or fertile female lives in a special large cell. The honey is carried by the bees to the comb in the

crop, whilst the pollen is kneaded up and carried in a depression in the tibia of the leg, which is surrounded by hairs and called the basket; this basket only occurs in the workers.

In India there are several common colonial bees. *Apis dorsata*, the big bee which builds large nests consisting of a single comb, either suspended to the under side of the branches of lofty trees or placed amongst rocks (this is the bee present at the Marble Rocks near Jubbulpore). It can be recognized by its size and elongated body. Its sting in the hot weather is very poisonous, even causing death when inflicted in numbers. *Apis indica*, a smaller bee which forms smaller nests in hollow trees, holes in walls, etc., and the small bee, *Apis florea*, which is about the size of a small house fly, and builds a single comb in the open upon branches of trees, etc., its honey being peculiarly sweet though small in amount. The wax and honey of *Apis dorsata* is sold in Indian bazars, as is also that of *A. indica* to a smaller extent. In parts of the country a certain amount of forest revenue is derived from this source. Besides the various species of *Apis* there are several species of *Trigona*, a group of small stingless bees which build in old walls, the nest being formed chiefly of chewed resin.

The *Bumble-bee* is closely related to the common bees; it lives in small colonies in nests in holes in the ground; each colony is founded by one large female, which lives through the winter.

The females of many *Solitary bees* hollow out small cavities in the earth or in wood or build cells of mud, pieces of leaves, etc. In these cells they store pollen or honey and lay one egg in each and then close up the cell. The larvæ on hatching out feed upon the store of food thus provided. Amongst solitary bees the commonest forms in India are the mason bees, *Megachile*, and the carpenter bee, *Xylocopa*. The mason bees build cells of leaf or mud, and are to be seen at work in verandahs, out-houses, etc., in dry weather in many parts of India. They store the cells with honey or pollen and deposit an egg in each cell and carefully close it up, leaving the larva to develop by itself. The *Xylocopa* contain some of the largest and most powerful of the bees. They are often black or blue-black in colour, and several of them bore into dry timber, and for this reason are called 'carpenter' bees. An Indian species bores into and riddles timber, such as beams and rafters of houses, tea-factories, etc., forming cells in the wood. Serious consequences occasionally follow the attacks of the *Xylocopa*, and a case came to the writer's notice where the roof of a large tea-factory in the Duars had to be entirely replaced owing to the damage done to it by carpenter bees.

FAMILY DIPLOPTERA (VESPIDÆ)—(WASPS).

The wasps have a simple trochanter and angled antennæ, reniform eyes and long projecting mandibles; the body is stalked

and the insects are provided with a sting; the most distinguishing feature is to be found in the wings, which are plicate, *i.e.*, folded longitudinally down the middle when the insect is at rest.

Some of the wasps are solitary, others—amongst them the genus *Vespa*, which contains the paper-wasps and hornets—are social and live in colonies consisting of males, females, and workers (the latter being barren females furnished with wings), and they build ingeniously constructed nests, consisting of a paper-like substance composed of chewed wood or bark. These nests consist of one or more horizontal combs, each composed of a number of prismatic hexagonal cells open at their lower ends. These contain the larvæ, which thus hang head downwards. The whole nest may be surrounded by a firm or loose covering. The larvæ are fed upon chewed insects. The whole population of the nest dies in the late autumn, with the exception of the young fertilised females. These survive the cold weather months and found a new colony in the spring, the completion of which is accomplished later by the workers which the female brings up. The adults feed chiefly upon sugary matter and fruit.

The commonest Indian wasps are *Polistes hebræus*—a small yellow wasp with long legs, common in verandahs—*Vespa affinis* and *Vespa velutina*—which build large nests in the forest—and *Vespa magnifica*—a large insect building in hollow trees and possessing a powerful sting.

Solitary wasps form cells in branches of trees in a similar manner to the solitary bees, and stock them with living insects or spiders, which they sting and paralyse. Having stocked the cell the female then lays an egg on the helpless inmate, closes up the cell and then dies. On hatching out the larva feeds upon the stock of living and fresh material thus provided for it by the female. A common one in parts of India may be seen stocking its mud cells with a green caterpillar.

Family Fossoria—(Sand Wasps).

Smooth-bodied insects, often with long legs and very like wasps, from which they are distinguished by having their antennæ curled and not elbowed. The front wings are not longitudinally folded. In habits they resemble solitary wasps, constructing either cells of clay or burrows in the ground or tunnels in the wood and stems of plants. In these they place the paralysed insects, laying an egg in each.

Others again, the *Scoliidæ*, which are hairy insects, frequently of large size, form no special receptacles for their young. They are parasitic, and lay their egs in the larvæ of other insects, which they first sting and paralyse in the position in which they find them in their homes. These wasps are therefore to some extent beneficial.

FAMILY FORMICIDÆ (ANTS).

The antennæ are elbowed and the ants can be distinguished from other *Hymenoptera* by the fact that they have a constriction in the stalk which joins the abdomen to the thorax. The trochanters are undivided. The individuals of each species are usually of three kinds :—males, females, and workers ; the latter have no wings, but the males and females are usually winged, though the females soon lose their flying organs. They live in communities of various numbers, the majority being workers. The larvæ are helpless maggots, fed and tendered by the workers or by the female. The pupæ are enclosed in silken cocoons, these being the so-called ant's eggs, which may be seen in fine weather exposed on the top of the nest to the warmth of the sun's rays.

Ants build nests which consist of passages and chambers dug out in earth and rotten wood, stumps of trees, etc., or they build in leaves which they fasten together. The burrowing ones generally pile up the earth they dig out in hillocks above the surface level.

The two most important sub-families of the ants are the *Formicides*, which have only one knot in their peduncle, the abdomen being not usually furnished with a sting, and the the *Myrmicides*, with two well-marked knots in the peduncle, the abdomen being usually furnished with a sting. The large yellow bamboo ants *Œcophylla smaragdina*, Fabr., with yellow workers and green males and females—which builds nests in trees by joining the leaves together, and is plentiful in many parts of India, and the large black ant—*Camponotus*—which constructs its nests in the ground and is a common example of the *Formicides*. *Camponotus* attacks other ants, and is to be found in attendance upon *Aphidæ* and *Coccidæ*. One of them has been found sucking the sugary secretion emitted by the Dun sal *Monophlebus* Scale. Amongst the *Myrmicides* may be noticed a large fierce ant, *Sima rufo-nigra*, called the sepoy ant in Madras from its colouration, with a red thorax and black head and body. It makes its nest in dead wood, and is often found in old longicorn borings in sandalwood trees in Coimbatore and Mysore. Its sting is very painful. The common red ant of the plains of India, *Solenopsis gemminatus*, which lives in large colonies in nests in the ground, under stones, etc. It constructs partially covered ways across roads and is often to be seen carrying off dead insects. It has been reported as attacking potatoes and may be found to do damage in nurseries ; a largish ant with reddish head and dark abdomen called *Holcomyrmex scabriceps*, Mayr., which is a granary ant and builds its nests in the ground and stores up grass and other seeds. Quite large heaps of grain are collected by these insects, which they may feed upon or simply allow to ferment and then feed upon the sugar contained in the fermenting mass.

Some ants are in the habit of keeping Aphidæ (plant lice) in their nests, which they use much as we use cows, sucking up the sugary secretions they emit.

USEFUL HYMENOPTERA.

The *Hymenoptera* contain several families of useful insects which tend to keep injurious insect pests, both in the forest and field, in check. It must, however, be borne in mind that the good is in some cases almost counterbalanced by the fact that the same families contain insects which are parasitic upon, and therefore keep in check, our useful insect friends. In spite of this, however, in the case of serious increases in the number of an insect pest, such as a plague of caterpillars, man is often deeply indebted to his hymenopterous allies. In this respect the *Chalcidæ* without doubt contain numbers of insects of great use, and their further study will well repay the trouble expended on it. Undetermined species have been already found attacking bark-borers, such as the Blue Pine *Polygraphus*, *Pityogenes*, and the deodar *Scolytus* beetles, and this is but a commencement in the great field ready for exploration. The next family of use to man are the *Ichneumonidæ* or ichneumon flies, which are *par excellence* a parasitic group, and more especially attack the caterpillars of *Lepidoptera*. Numerous wild silkworms are subject to these attacks, and amongst forest defoliating caterpillars kept in check by them may be mentioned *Lymantria* (several species), *Dasychira*, *Acronycta*, *Hyblæa puera*, etc. Future observations will add many more to the list. The family are of use also in keeping the wood-boring grubs, both coleopterous and hymenopterous, in check, the genera *Rhyssa* and *Thalessa* being of particular importance in this respect. A species of one of these genera is parasitic upon the Indian spruce sirex. The *Braconidæ* or supplementary ichneumon flies as they are sometimes called, resemble in habits the *Ichneumonidæ*, and they are of interest in the forest, since already species have been found parasitic on the larvæ of the *Scolytus* deodar bark-borers, and researches will probably show that there are many other similar cases.

The *Apidæ* must be classed amongst the useful *Hymenoptera*, not on account of any predatory habits, but owing to the fact that they furnish man with certain products, such as honey and wax, which add to his food and comfort. There is yet another and important part played by this family in Nature. Bees undoubtedly help largely in the distribution of pollen, and therefore in the fertilization of the flowers of trees and shrubs, and consequently in the continuance of vegetable growth. It is not improbable that the family is of great service to the forester in this way.

The *Diploptera* (wasps) and the *Fossoria* (saw-wasps) both paralyse and lay their eggs in caterpillars and other insects, and therefore are of some use in keeping down pests. The sand-wasps

also attack grasshoppers, probably several times their own bulk, and lay their eggs in them.

Little is known about the *Scoliidæ* in India, but in Madagascar a species lays its eggs in the rhinoceros beetle (*Oryctes*) which attacks palms. It may be found that a species infests and keeps in check the *Oryctes* in India when it is a serious pest at times.

Amongst the *Formicidæ* present available information does not show that they are of much use. The bamboo ant, *Œcophylla smaragdina*, feeds largely upon caterpillars, and so is possibly of some use in keeping down defoliating pests.

Taken as a whole, the order may be looked upon as one of considerable use to man.

II.—CORRESPONDENCE.

Chloroxylon Swietenia.

Flindersia, a tropical Australian genus of trees and shrubs, with one species in New Caledonia and one on Ceram Island, and *Chloroxylon* (monotypic) are classed under *Rutaceæ* (sub-order *Flindersioideæ*) by Engler in Engler u. Pranll Natürliche Pflanzenfamilien, III. 4. 111, 170. Doubtless there are strong arguments in favour of this arrangement. As Mr. Lushington points out in his late communication on *Chloroxylon*, the leaves have pellucid glands and are aromatic, not bitter. Further, the stamens are free; a character which Kanjilal, in his most useful key to the Natural Orders, properly uses to separate *Rutaceæ* and other Orders from *Meliaceæ*; they are connate only in two species of *Atalantia* and more or less connate in *Citrus*, while they are free, among Indian *Meliaceæ*, only in *Walsura robusta* and *Cedrela*.

On the other hand, there are many points of resemblance between *Cedrela* and *Chloroxylon*, and there is this important fact, that *Flindersia*, which undoubtedly is closely allied to *Chloroxylon*, has a cup-shaped disc, enclosing the ovary, similar to what we find in most Meliaceous genera.

Chloroxylon is one of the numerous instances which illustrate the imperfections of our present arrangement of phanerogamous plants. Our Natural Orders must be regarded as a makeshift only. A non-natural system of species and genera might be built up, not by using length and breadth of the sheet on which we write, but by employing the three dimensions of space. Such a system of phanerogamous plants would resemble a huge building in which *Chloroxylon* would occupy a corner, surrounded on all sides, as well as above and below, by allied genera.

When *Indian Trees* sees the light, which I hope will be some time next year, my young friends in India will see that in some important cases I have been compelled to adopt an arrangement different from that of the *Genera Plantarum* and the *Flora of British India.* In the case of *Chloroxylon* I did not think such a deviation from the English standard works necessary, but only added a remark pointing out the strong argument for the arrangement adopted by Engler.

I congratulate Mr. Lushington that, evidently without knowing Engler's work, he has arrived at the same conclusion as this distinguished botanist.

D. BRANDIS.

Percentage of Essential Oil in Sandalwood.

IN my notes on the sandal tree, which were published in the 'Stray Leaves' of the *Indian Forester* in 190', I stated that, in my opinion, the richness of the wood in oil was dependent rather on the elevation and exposure than on the soil.

I had then found sandal growing freely in a tank bed in the Erode Taluq at an elevation of about 700 feet. I found no trace of heartwood either in the stem or roots, and a billet, when subjected to an analysis, did not contain even a trace of essential oil.

I have now had an opportunity of examining the growth in the Tinnevelly district, where the tree is noticeable in two localities. At Courtallum the tree is fairly abundant between an elevation of 700 and 900 feet. In this locality no big trees are found. In the Alagarkovil valley of the Srivilliputtur forests the tree is to be found growing freely at an elevation of 900—1500 feet with a fair percentage of big trees. In order to test the quality of the wood grown at this low elevation, I had twelve trees, which were grown between 900 and 1200 feet, cut and cleared. From them I obtained 5mds. 14lbs. of scented wood. The wood was of a light yellowish brown and very deficient in scent. The wood sold at a rate of Rs. 3-12 per maund, which was a far better price than I expected to realise. Three of the billets, selected haphazard, were subjected to analysis and yielded respectively 0·24, 0·54, 0·46 per cent. of essential oil.

In 1896 whilst at North Coimbatore I had two billets, grown at what I consider the most favourable elevation, *viz.*, 2500 to 3500 feet, analysed. One gave 1·94 and the other 2·44 per cent. of essential oil.

There seems, therefore, to be a regular gradation in the richness of the wood dependent on the elevation, and it would be interesting if this could be put to the test in a district which is really rich in sandal.

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At the same time there seems to be a limit reached at about 3500 feet, though in North Coimbatore, at Osahatti and elsewhere, sandalwood is growing well at higher elevations. I believe that some fellings have been recently undertaken in Coimbatore at these higher altitudes, and it would be interesting if the results were published giving the quality of the wood obtained and its richness in oil.

PALAMCOTTAH : 11*th November* 1902.

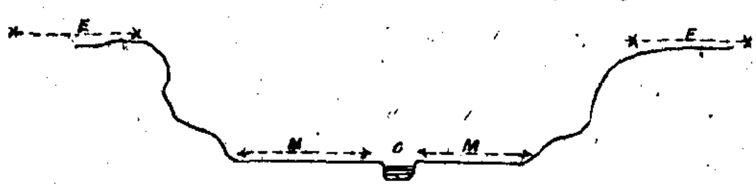
P. M. LUSHINGTON,
Deputy Conservator of Forests.

A Peculiar Type of Teak Forest.

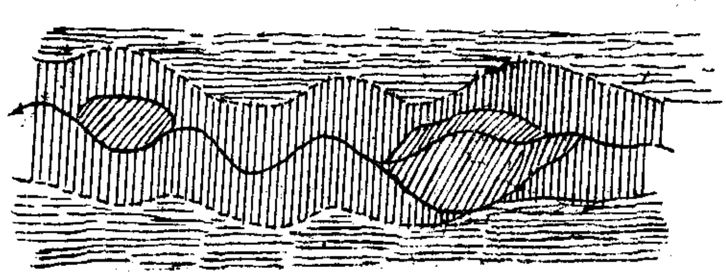
I SEND an extract from my diary, as someone may be able to answer the question as to how this peculiar kind of teak forest came to be formed, as so far I am still at a loss to explain it.

"Girdled 63 trees to-day; the teak forest in this creek (the Kugyi) is of peculiar formation known locally as 'waiks.' These *waiks are islands of teak always far apart in the moist jungle* bordering the creek.

"The moist jungle is never more than a few hundred yards broad, then gives place to hills covered with Engdaing.



c = creek. E = Engdaing. M = Moist forest, evergreen.



//// Teak |||| moist (Evergreen Forest) E ═ Engdaing.

"The maps, section and plan will explain what I mean. The trees are of gigantic size, as it is useless in my opinion having a tree of 13 feet girth and over. Seedlings are totally unrepresented, *and saplings none or very scarce. Same may be said for second and* third class trees. It is astonishing to me how the teak originally

got here and only in these 'waiks.' Why not all along the moist forest? as I have seen similar forest in the Chindwin, only the teak there was not in spots like here, *i.e.*, the Nampanan creek, Sanda Reserve."

I should note that these "waiks" usually contain trees mainly of the same size, as subsequently I came on to "waiks" of teak containing hundreds of thousands of saplings (these waíks are well known and have names): it is true these were near villages, and all the old trees had been cut out, but in the waiks of gigantic trees only now and then a stump would be found showing where some extra-fine giant had been extracted, long ago, to make a boat hull.

C. Bruce,

Mogok. *Deputy Conservator of Forests, Ruby Mines District.*

The occurrence of a different type of forest in the valley to that on the neighbouring hills is, we expect, due to geological conditions, the beds of laterite which generally accompany "Engdaing" having probably been eroded in the valley.

The 'waiks' of teak have long been a puzzle: perhaps they are the remains of an older type of forest, which is being gradually encroached on by the evergreen type.—Hon. Ed.

III.—OFFICIAL PAPERS AND INTELLIGENCE.

Report on Spike Disease in Sandalwood Trees in Coorg.

No. 541, dated 24th July 1902.

From—C A. BARBER., Esq, M.A., F.L.S., Government, Botanist, *Madras*,

To.—The Secretary, Board of Revenue, Madras.

I HAVE the honour to forward the following report upon the "spike" disease in the Coorg sandalwood trees.

2. As will be known to you, I was only able to spend a short time on the spot, and although this would frequently be amply sufficient to determine the cause of a plant disease, there are a

number of points in the present case which have not been elucidated. The result of my studies has been to trace the disease to the roots, but the exact cause of this diseased condition has not been determined. A number interesting facts have been collected regarding the life-history of the sandalwood, and these should put any future observer in a better position to clear up the mystery, especially if he has a laboratory equipped for cryptogamic work.

3. The disease seems to be of recent origin. It so happens that, from the appearance of the branches, it is possible to tell whether a dead tree has died of "spike," and as only the dead trees are collected for the sandalwood of commerce, it is probable that the disease, if of long standing, would have been noticed before. However that may be, the first reference to it is, I believe, the detailed report of Mr. McCarthy, the present Deputy Conservator of Forests in Coorg. To all appearance "spike" has only made itself felt during the last four of five years, and during that time has swept the sandalwood trees from whole tracts, especially where, from artificial planting or other causes, the trees are near together.

A.Progs. (Working-Plans) June 1900, Nos. 9-12.

4. The steady progress from plant to plant, the complete destruction of all plants, excepting very young ones, in attacked areas, and the frequent immunity of isolated trees seem to point most decisively to the presence of a definite communicable disease, and not to peculiar phase of growth due to conditions of weather or soil. From certain facts it would appear to be contagious, whereas in some cases it is difficult to see how the affected trees could have touched each other. The determination as to whether the disease is contagious or infectious would add a good deal to the ease with which it could be diagnosed and prevented.

5. Upon my arrival at Fraserpet, the spot selected for my study of the disease, a very careful analysis was first made of the external above-ground characters of the affected trees. The following is the description published by Mr. McCarthy :—"The new shoots and leaves of a tree, instead of presenting the graceful appearance natural to the species, begin to grow out stiff and straight: the leaves also stand up stiff and erect like bristles, and as their arrangement is opposite and alternate, the shoot looks like a spike with four lines of erect leaves growing down it, something like a chimney brush. There is no discernible change in the new axis, except that it grows out stiff and straight. As regards the leaves, in the first place the distance between the alternate pairs is greatly decreased, then the petiole and blade are tip to tip in one straight line, and lastly the blade is shorter, narrower and more pointed. However, there is no sign of spot or sickness in the leaf substance. As the disease progresses, the new leaves become still smaller, narrower, more pointed and fewer each

successive year; until the new shoots present the appearance of fine spikes bearing 4 rows of fine bristles. After this the tree rapidly dies off."

6 This is an excellent and accurate description. But as the best description in woods are not always easy to understand, I have appended a series of photographs and poisoned herbarium specimens which may be consulted as well.

7. I shall first describe the appearances in old and young trees recently attacked by "spike," and, after that, a young or old tree in the last stage of the disease. The first photograph represents an old, luxuriant tree, only recently attacked. It appears extremely *healthy and full of foliage*, but a close inspection shows that many of the branches are peculiarly formed. The latter have a feathery appearance, the leaves are smaller, narrower and more pointed; they are closely arranged on the branches, and there are no flowers. These are the spiked branches. It is to be noted that such a tree is not uniformly attacked all over. Certain branches, frequently widely separated, are seen to be completely spiked, while the neighbouring ones are normal. In fortunate cases it is possible to detect the commencement of the disease in a branch. Parts of it are spiked and barren: others normal and flowering (see herbarium specimen No. 3). In such branches it is generally possible to detect cases of phyllody, the inflorescence giving place to a tuft of leafy shoots and the flowers often being deformed, some or all of the sepals, petals, stamens or pistils being changed to small green leaves.

8. There appears to be no necessary connection between the parts of the tree which shows "spike." Healthy trees are occasionally met with in which there is no appearance of the disease other than a tuft of small leaves at the ends of one of the branches. Sometimes too small branchlets, at different points, simultaneously develope the small, crowded leaves —just as in witches' brooms—while at other times—and this is the case in the tree photographed—one-half of the tree is more or less spiked, while the other half produces flowers and fruits as usual.

9. There are certain points in which a young tree just attacked differs from the old, well-grown tree just described. It is less usual for the individual branches to show such marked differences among *themselves. The lower leaves of a branch are* normal, while the upper ones show the appearance of "spike" and phyllody. Thus you may frequently find a young tree, the whole of whose branches have normal, large leaves below, with small spiked tufts at the ends (see photograph No. 4). The period during which the whole tree becomes involved is probably far shorter in these cases, and a young plantation, where "spike" has entered, becomes rapidly destroyed and shows in the clearest manner the various stages of the disease.

10. From all accounts the progress of the disease is very rapid, and the transition from a luxuriant tree, with many healthy leaves upon it, to the case of advanced disease about to be described may be merely a matter of months; but exact observations are wanting on this point.

11. The following are the characters of a young or old tree where the disease is well developed and in an advanced stage. At a distance the tree appears to be dead and leafless, or perhaps better, it appears to be pronouncedly deciduous, reminding one strongly of an English tree in winter. A nearer inspection shows that there are many leaves scattered over the tree at the ends of the stiff branches, but they are very small indeed and form little brush-like terminal tufts. The branches are, however, full of sap. The leaves are very different from the normal, healthy ones, exhibiting in an exaggerated manner the form of those on the feathery branches already described. A student confronted for the first time with healthy and diseased sandal trees would at once pronounce them to be different species.

12. A marked character of all the diseased plants which I have examined is the absence of any external appearance suggesting the presence of any parasite, animal or vegetable. It is true that, at first sight, the idea of witches' brooms suggests itself. But there are many respects in which the present disease differs from these, especially in the fact that the whole tree is surely, though perhaps slowly, affected, and that the abnormal appearances are not confined to single branches. There is also the most perfect regularity in the leaf formation, and there are no deformities anywhere to be seen.

13. The absence of flowers was the first point to be investigated. The occurrence of phyllody is one of the most puzzling parts of the disease. This peculiarity is frequently due to excess of nutrition, whereas any injury to the roots most generally results in a great development of flowers and fruits. But the phyllody in this case is not accompanied by increased luxuriance. The leaves, on the other hand, become successively smaller, until the leaf surface is insignificant as compared with that of healthy plants. The causes which induced phyllody in garden plants cannot therefore be considered here. It is more probable that in this case, as will be seen directly, the excessive and rapid formation of leaves points to an attempt on the part of the plant to cure itself of a grave disease.

14. There appears to be no absolute rule as to the period at which the sandalwood flowers. But, when it does, it is usual for each branch to end in an inflorescence, and, further, for each of the latter to end in a terminal flower. It is obvious that when a flower bud is formed at the end of a branch, no further growth would possibly take place until another vegetative shoot could

replace it, and this does not, I think, usually take place until the flower has developed and formed its fruit. There is thus a considerable resting period, at any rate from leaf formation, in the normal life-history of the tree. Supposing through some reason the formation of flowers were to be prevented, this resting time would not be available, and leaf after leaf would be formed in rapid succession. It might well be that, just as in the case of a temperate plant deprived of its winter's rest by being introduced into the tropics, excessive leaf formation might result in ultimate exhaustion. And the sign of this exhaustion would be seen in the decreasing size of the leaves.

15. It is well known, however, that phyllody is also caused by the attacks of various parasites. Different fungi attacking the tissues of a plant, cause the flowering branches to develope into leafy, barren ones. In fact a case has been noted of this, occurring in a Thesium, one of the sandalwood's nearest allies, and like it, a root parasite. A microscopic examination was therefore made of the vegetative shoots and their young tissues in spiked plants. There was no evidence at all of any attack, nor was any foreign body found in the cells.

16. But this examination brought one significant fact to light. All the tissues of the diseased branches, even to the smallest twigs, were found to be loaded with starch. Since the main function of the leaves in a plant, as far as nutrition goes, is the formation of starch, it appeared that they were, in this case, doing their work excellently. In healthy branches of small size, however, there was no starch at all. As fast as it is formed this substance is hurried away to be used up in the processes of growth. There was then evidently a sign of stagnation in the diseased plants. For growth, besides the starch formed in the leaves, a plant has need of other substances—salts and water—which are contributed by the roots. In the diseased plants growth had ceased to a large extent, and they were dying with their tissues loaded with undigested food. This fact pointed very distinctly to the roots as the place where trouble might be sought. A certain amount of water and salts is always present in the stem and roots and leaves, and, supposing further supplies of these substances were cut off, this limited quantity would be sufficient to keep things going for a time. This would account for the formation of the leaves in spiked trees, and would also account for their being smaller and smaller until the final death of the tree.

17. Certain other facts may be mentioned in this place as tending to confirm the impression that the roots were diseased. Mr. McCarthy has noted that all the branches of a tree which show "spike" usually do so in the same stage. The disease appears to be one which attacks the plant as a whole, and, although it may not succeed in overcoming the whole tree at once, we do not meet with branches of early and late stages. They

are merely spiked or not ; if healthy, then normally so ; and if spiked, they are all spiked to the same degree.

18. Another fact of interest is that *rootsuckers*, or *shoots* sent up from injured roots, are almost always spiked in trees suffering from the disease. I have, indeed, met with a tree which appeared perfectly healthy, and yet every rootsucker was spiked and formed such a marked contrast to the stem branches that they would have been unhesitatingly assigned to different species of plants had it not been possible to trace the connection between the two.

19. Although I had not the opportunity in the time to make a thorough study of the way in which the disease had spread over the country, the observation of a series of spiked trees, their relative position and the various stages of the disease gave one the impression that the attack was progressive, but whether by contagion or infection could not be determined. Taking a set of diseased trees which were selected for careful study, it was found that, while they were all dead or in advanced stages at one end, those at the other were healthy or showed signs of recent attack. Further observations are called for on this point, and an accurate account of the progress of the disease in certain isolated and well marked areas would throw much light on the best way to fight the evil. In the series of specimens referred to above, the direction in which the disease had spread was along the banks of the Kauvery, where countless roots were exposed by the fall of the sandy banks.

20. The examination of the above-ground parts, and the collection of specimens for microscopic work, had taken up so much time that only two days remained for the roots. All the facts noted above were not observed at one time, and it was only the chance discovery of the abundant starch in the tissues of the young shoots which definitely pointed to the roots as the diseased organs. The leaves were doing their work of starch formation ; what were the roots about ? The collar was examined in several trees, but it showed no disease which might account for the cutting off of supplies. The main roots were living and apparently healthy. It was only after long search that it was discovered that there was something seriously wrong with the root-ends.

21. The root system of the sandalwood is very peculiar and does not seem to have received the amount of attention that it ought to have done. As compared with other trees around, this is the part of the plant which is most characteristic, and attention should therefore have been concentrated upon it in the numerous plantations. It is averred in text-books that the tree, like *Thesium* and others of its class, is a root parasite, that it attaches its roots to those of other plants and sucks their juices for its own growth. But the pronouncements of the various forest officers,

who have written upon the subject are vague in the extreme. Most appear to be doubtful, while some boldly affirm that the sandalwood is not a parasite any longer, having lost the power which it formerly possessed. This is an extremely erroneous statement. The smallest examination proves that the roots of the sandalwood are inextricably united with those of other plants, and that the plant is a greedy and constant parasite. It is moreover to be noted that the development of root-hairs, by which a plant becomes intimately connected with the smallest particles of soil and absorbs water and salts from them, are almost entirely absent in those that I have examined, and it becomes a question as to how far the sandalwood roots are able to act like other roots in the procuring of their food. Upon contact with the root of another plant the sandalwood root forms a small swelling or cushion at the touching point. From the centre of this is produced a sucking organ, and the juices of its host are used for its own purposes I consider it probable, from my own observations, that the sandalwood roots at any rate in Casuarina or Lantana plantations, do very little true root-work on their own account, and are dependent almost altogether on their hosts for their supplies of water and salts.

22. An examination of the roots of spiked trees shows that their sucking organs, or "haustoria" as they are technically termed, are absent or dead. It is a matter of some difficulty to follow the roots to their termination without breaking them. For two whole days my staff were carefully dissecting the earth away and laying bare the root systems of spiked and healthy trees, with the invariable results that all the root ends of the spiked trees wear dead and rotten. That there is a root disease present, then, I have no manner of doubt. As regards the exact cause I have not had the means of judging. It seems to me that this is a suitable piece of work for the Cryptogamic Botanist to the Government of India.

23. Bearing these facts in mind, the following is what appears to happen in spiked trees, although I cannot profess that all the phenomena are explained. An injury occurs to the roots and their ends die: the supplies of salts and water are thus cut off from the plant. This does not take place all at once, for there are a great number of root-ends to be affected, and there is also a certain quantity of salts and water stored up in the stem and main roots: the shortage in the supply of the salts needful for seed-formation accounts for the cessation of flowering: fresh roots are needed and fresh leaves are called upon, at an unseasonable period, to produce the necessary material: the branches continue in their growth, which is not terminated by the formation of a flower, and new leaves are formed in rapid succession: the old leaves are thrown off, and the new ones formed are smaller and smaller: by their active metabolism, the tissues, even to the

smallest twig, are filled with starch which has no chance of getting away: the tree finally cannot stand the strain, and having used up all its supplies of salts and water, finally dies of exhaustion.

24. A number of other facts were observed, and as these may throw light on the study we are engaged in, they are appended. In the few cases where I was able to properly examine the roots of spiked trees, I noted that the Lantana roots near were much diseased, and at first it naturally occurred to me that the supply of poisoned food was quite sufficient to kill the sandal roots parasite on the Lantana And this may, to some extent, be the case. Mr. McCarthy has noted the coincidence of the spike and the Lantana invasion of Coorg. This is a point well worthy of further observation. The Lantana has got such a hold of the country around Fraserpet that nothing short of devastating disease can free the country from it. If it is found to be in some way connected with "spike;" then the first thing to be done is to stem the torrent of invasion, and thus to save those portions where the Lantana has not yet arrived. "Spike" is well developed in the Hunsur neighbourhood, and Mr. McCarthy states that it originally came from Mysore into Coorg. I have heard nothing about the presence of the disease in the Hassan District, but little seems to be known about it, and I think it would be well to interest the Mysore Government, so that accurate observations may be made regarding its presence and connection with Lantana.

25. The known healthiness and rapid growth of sandalwood trees in Lantana and Casuarina plantations have been, I believe, usually attributed to the particular kind of shade afforded, and the occurrence of leaf-mould beneath the trees. I do not think that Casuarina is a tree which offers much advantage in the latter respect. On the other hand, the two Casuarina-*cum*-sandal plantations, which I was able, through the kindness of the Dewan, to visit near Bangalore, at once showed that the sandal is as greedy in its attachment to the Casuarina roots as it is to those of Lantana. I would therefore explain the early success of the sandalwood in these plantations as due to the abundant nutriment offered by the surface roots of the nurses rather than to the kind of shade, and especially so since the shade differs so markedly in the two cases. The study of the sandalwood plantations from this point of view—to my mind the most important by far—has been altogether neglected. A thorough biological study of the root system, its likes, its dislikes and its dangers, would be far more productive of useful results than much of the haphazard planting of former years.

26. I would add, as contributions to this interesting study, that the Casuarina roots in the two Bangalore plantations examined, were badly infected with a parasite resembling that of the well known alder root tubercles. The sandal roots frequently

attach their haustoria to their own roots, an operation resulting in curious fusions among the older roots. The poor development of root-hairs in the sandalwood roots suggests a saprophytic as well as parasitic habit. This is in accordance with the experience gained that the seedlings require leaf-mould for their first year. I have found the seedlings firmly attached in all directions to the roots of grasses and other plants, statements to the contrary notwithstanding. While examining the diseased roots of the sandalwood after leaving Coorg, I observed, besides a few hyphæ, not in themselves sufficient to account for the death of the rootlets, certain peculiar bodies in the vessels. These upon examination turned out to be thyloses, or protusions of the living cells into the cavities of the empty vessels, due to great pressure. Many of these thyloses were filled with starch, thereby increasing the storage room for this overabundant substance. But their chief function perhaps in the tissues is to stop up cavities through which injurious influences might reach the interior. Here, on the death of a rootlet, the wide vessels afford easy entry to parasitic fungi and bacteria, besides the smaller forms of animal parasites. An attempt is made by the root to stop up the vessels by the formation of thyloses as stoppers. That this view was the correct one received unexpected confirmation from a section through a haustorium which had attached itself to a sandal root. At the point where the sucking organ was endeavouring to enter the vessels they were protected by an abundant formation of thyloses which stopped up their cavities.

27. A difficulty which occurred to me was, that when a plant is spiked and its root ends are dead, there appears to be no attempt on its part to form fresh adventitious roots from the older parts of the root system. This fresh formation of roots frequently takes place in other plants when they are attacked and destroyed by parasites. But it has been mentioned that very young trees do not show "spike," and I would suggest that in these cases the roots are still in a sufficiently plastic condition to form new ones above the point of injury. The roots of the sandal probably quickly pass into the permanent condition as far as root-formation is concerned. The young trees keep up the fight as long as they are able to form fresh roots, but as soon as this plastic condition is passed they too succumb to the disease.

28. In the old plant we have seen that "spike" usually appears suddenly on one isolated branch or part of the tree, so that you see, in the most curious juxtaposition, normal, flowering and fruiting branches and barren spiked ones. Sometimes one-half of a tree is completely spiked, while the other half is healthy. A young plant, on the other hand, frequently goes off into "spike" all over at the same time. This is probably due to the much larger area of the root system in the older tree. As will be seen later, the roots may extend for very considerable

distances. While the whole of the root-system in young plants is very quickly invaded, it takes a very considerable time before this can occur in the case of an old one. It is quite possible also that certain parts of a tree are fed by certain portions of the root system, although there are generally in plants special arrangements for cross connections in case of sudden injuries.

29. In an old plant, such as that reproduced in photograph No. 1, it may be noted that a great many of the spiked branches are such as have been shortly broken off (see photograph No. 3). This at first led me to suspect the entrance of some parasitic fungus at the broken surface. But the examination of the spiked shoots did not show the presence of any fungus, and the tissues were perfectly healthy. It appears, however, that *any* late developing branch on a spiked tree is likely to be spiked. Such are the epicormic branches from various parts of the stems of old trees, and so also are the rootsuckers arising from injuries to the roots. Probably the shoots of the broken off branches are also of this character, being formed late to replace the branches which have been removed. It is worth while also pointing out that all these late formed branches are produced as the result of some injury to the plant.

30. One cannot note the way in which the disease spreads over the country without suspecting the roots as passing on the disease. When the trees are near together, as in a plantation, in a comparatively short time the whole of them are infected. Where they grow along the banks of a river the direction of progress is along the banks. Where finally the trees form isolated clumps in the middle of fields, they are frequently quite healthy, although comparatively near to series of diseased plants. This is a fact that was pointed out to me by McCarthy, and it is quite in keeping with the idea of spread from root to root underground. I may incidentally mention that the roots are far more wide-spreading than might at first be supposed. They probably live long after the trees to which they belong have been removed, and rootsuckers spring up when it is impossible to tell whence they have arisen. In one case I had a root dissected out and it extended to the astonishing length of 100 feet, although I had not reached its end, and this was in a nearly straight line across the field.

31. The conclusion arrived at thus far is that the disease called "spike" in sandalwood is due to the death of the root ends. What causes this has not been determined. An examination of the material brought to head-office has not thrown any light on the subject. The hyphæ present in the dead roots do not seem to me to be present in sufficient quantity to cause this state of things, and to infer a bacterial disease would be obviously a plea of inability to find an adequate cause. The bacterial diseases of plants are few and of doubtful character, and there are none of the lesions and mal-formations in the tissues in the present case

which would be expected to accompany a bacterial disease. A more careful study of the root ends, which was not possible in the time at disposal, and especially of those not yet dead, would perhaps give a clue to this puzzling disease.

32. Meantime, the progress of the disease should be carefully noted. It seems to me most probable that it is spread from plant to plant by means of the roots. There are no appearances of infection in the leaves and young branches. If it took place through the broken surface of the stem, what plant could escape? There is no tree perhaps so much hacked about and so covered with wound-callus-formations as the sandalwood.

33. Some interesting experiments might be conducted. If the phenomena noted in the above-ground parts are merely due to the failure of the roots, then it should be easy to induce them by cutting off root after root of a healthy plant and watching the new shoots forming on the trunk and branches as well as the root-suckers. Branches might be broken off from a tree where the disease has just made its appearance in order to see if the fresh shoots formed will be spiked. Diseased roots may be brought into contact with healthy ones with small difficulty and the evidence obtained as to whether the disease is readily transmitted from tree to tree by this means. But it is perhaps early in the enquiry to formulate more of these experiments. There is no doubt that a grave disease has appeared among the sandalwood plantations and forests, and it will rest with those concerned whether they prosecute further the studies thus commenced.

Imperial Institute.

Quarterly Report on enquiries conducted for the Government of India by Professor Wyndham R. Dunstan, M.A. F.R.S., Sec. C.S. Director of the Scientific and Technical Department of the Imperial Institute.

SINCE the date of my Annual Report on the work conducted for India in the Scientific and Technical Department of the Imperial Institute, Flying Seal letters have been received advising the despatch of a large consignment of the pods of *Caesalpinia digyna*, which is required for the purpose of conducting tanning experiments on the large scale. Advice has also been received of the despatch of the promised large instalment of the barks of *Shorea robusta* and *Terminalia tomentosa*, which are being investigated with the view of obviating the purple tint which is communicated to leather tanned with these materials.

2. Advice has been also received of the despatch of samples of *Hyoscyamus muticus* for comparison with the Egyptian plant, which has proved to be an important source of the alkaloid Hyoscyamine. Samples are also being forwarded of *Hyoscyamus niger* from Saharanpur, with the request that these species may be submitted to chemical investigation. There is now a considerable

demand in the English market for different species of Hyoscyamus; so that it is important that the constituents and medicinal value of the Indian species should be precisely determined.

3. The Reporter on Economic Products has also forwarded four samples of tobacco from Assam for chemical examination and an expert opinion on their value. These samples have now been received, but their condition is very unsatisfactory, having apparently undergone deterioration during storage and transit. It is feared that they will be of little value for purposes of commercial valuation.

4. A sample of the fibre of *Agave americana* from Cachar, Assam, has been also received for analysis and valuation. It is at present under investigation.

5. The Reporter on Economic Products has asked for a report on samples of Asbestos from Central India, and has announced his intention of making this product one of the subjects for investigation during the current year. The use of asbestos in this country has considerably extended during recent years, and uses have now been found for inferior grades of the mineral, even when it is composed of short friable threads, and there is no doubt room for the further development of the trade in the Indian material.

6. The Reporter on Economic Products has also requested to be supplied with information as to a fire- and water-proof cement for joining mica. Workers with mica in this country have been asked for their opinion on this subject.

7. I have also to add that since the date of my last report a paper by Dr. Henry and myself on the poisonous constituent of young "Dhurra" or "Juar," the "Great Millet" (*Sorghum vulgare*) has been communicated to the Royal Society, and an abstract has appeared in the Proceedings of the Royal Society for June 1902. I may also mention that at the two soirées at the Royal Society, held in May and June last, specimens of the principal Indian products now under investigation in this Department were exhibited together with the results of their chemical examination, and that these exhibits attracted considerable attention.

8. In February of the present year I read a paper on "The Coal Resources of India" before the Indian Section of the Society of Arts. This paper has now been issued by the India Office, together with a large map of India showing the coalfield and railway communications alluded to in the paper. The paper can be purchased through the Agents for the sale of Indian official publications, and copies have been placed on sale in the Indian Section of the Imperial Institute.

WYNDHAM R. DUNSTAN,
Director, Scientific and Technical Department.

11th July 1902.

The Rapid Ageing and Fireproofing of Wood.

THE preservation of wood was formerly accomplished by drying and covering it with coatings designed to prevent the entrance of air and moisture. These have given place to numerous plans for the introduction of antiseptic liquids.

The decomposition of wood occurs soon after it is felled and exposed, whether in logs or pieces, to the air, moisture and variations of the temperature. It is also destroyed by being buried in the ground or immersed in water. Cut up in planks and dried in the open air it warps and cracks, causing considerable loss. At 300 deg. C. all wood, dry or preserved by antiseptics, is carbonized without production of flame, but subjected to a red heat or to the action of a burning body, as in fire, the pieces of wood are completely destroyed, even if they are covered with a coating opposing to the fire a certain resistance. Whence the multitude of processes made use of for more than a century for increasing its durability.

Let us consider in a few words what wood is, the properties of its principal components, and the causes of their rapid change.

Wood is formed essentially of two different substances, one predominating, the ligneous, and the other liquid, the sap.

1. The ligneous is formed of cellulose, that is, with reference to its elements, of carbon, oxygen and hydrogen. This organic tissue constitutes the framework of the plant, in the form of vessels and fibres, which are covered with an agglutinant organic matter (vasculose, cutose, pectose, etc.) The principal cause of change of the ligneous is the great affinity of its carbon

for its oxygen, an affinity favoured by the changes of dryness and moisture, and finally resulting in the disorganization of the fibrous structure. The wood loses its power of resistance, the fibre is disintegrated and falls into a grayish powder.

Pectose and pectic acid, in the state of pectate of lime, form a part of the organic cement which binds together in bundles the cortical fibres of a great number of useful filamentous plants.

Pectose, like cellulose, is insoluble in all neutral solutions, but it has the property of conversion under different influences into soluble gelatinous products. Submitted to the double action of heat and of acids, it is transformed into pectine, a neutral colourless body, soluble in water, then into pectic acid C_{32}, H_{48}, O_{32}, and quite a series of bodies increasing in acidity in proportion as they recede from their origin. These bodies may be presented in the following order: Parapectine, metapectine or parapectinic acid, pectonic acid, pectic acid, parapeptic acid and metapeptic acid.

2. The sap which fills the cellular cavities of the organic tissue is composed of a considerable quantity of water, holding in solution mineral and organic substances (nitrogenized, fatty and sugared). The sap passes by endosemose, and not by capillarity, from the soil into the roots; then circulates through the different parts of the plant, conveying various dissolved mineral substances such as are found in the ashes. This liquid, therefore, is one of the essential causes of the vitality of the wood. After it is cut down, the sap, undergoing the affinity of its carbon for oxygen and of its nitrogen for hydrogen, becomes a favourable medium and an aliment for the nourishment of worms and for the development of cryptogamic germs—additional and powerful causes of the changeableness of wood.

The sappy liquid represents a weight varying from 15 per cent. in the yoke-elm to 50 per cent. in the poplar.

Not only are the chemical and physiological causes of the changes of wood now understood, but a remedy has been found for the evil. It has been known for a long time that a dry wood is much less subject to decomposition than a moist wood still impregnated with sap. This observation has led to submitting the wood before its employment either to natural or to artificial and rapid desiccation.

Until within the last few years the first method, the most simple, that of exposure to the air for a time, afforded good results, but the natural drying, which requires a good deal of time, especially for hard species and for considerable thicknesses, necessitates a very large surface for piling wood and the loss by waste proceeding from splits at the extremities increases the price

of dry wood. This explains the numberless methods for obtaining the rapid drying of the wood under the best possible conditions.

To describe all the processes would take us too far from the parts of the subject which we have in view. Paulet describes 173 methods, most of which have been patented, and which may be distributed in the three following groups :—

1. By natural infiltration or displacement applicable to standing wood or that recently cut down.

2. By pressure in the open air, applicable to wood in bark; or by pressure in an inclosure, applicable to dry wood.

3. By superficial application of antiseptic agents (by carbonization, immersion and coating) useful for all kinds.

Before considering the ingenious Nodon and Bretonneau process for the rapid ageing and fireproofing of wood, we will rapidly analyze the principal methods which have afforded material results.

In the first group may be mentioned rafting, which consists in immersing the pieces in water. This allows of drying the wood more rapidly, for the sap having been partially driven out by the water, which has replaced it, this will evaporate more readily than the sap. For instance, oak for flooring, which would require two years of drying in the open air, may be dried in four months after having been subjected to the action of the water.

Wood is immersed in a stream or basin for three or four months. If the circumstances allow of raising the temperature of the water to 30 deg. C., the time of operation may be reduced to fifteen or twenty days.

Steam also afforded good results so far as the drying is concerned, but unfortunately the fibre is in part attacked and the wood is much less tenacious.

In the Leclerc process the operation is conducted by steam, followed by drying in a current of warm air. The wood is arranged in a close chamber of masonry and the steam, strongly distended, is brought in for forty-eight hours by perforated pipes. Under the action of the condensed water a part of the sap comes from the cells of the wood, and the other part is coagulated. Thus the result is not complete.

The wood is afterward dried by causing a current of warm air (30 to 35 deg. C.) to circulate in the same chamber, which requires a fortnight for planks of ordinary thickness. The wood is piled upon the open work floor of the chamber, inclining it sufficiently to cause the sap to flow. Each piece is separated

from its neighbours, which allows the air and steam to circulate freely over the whole surface. For drying, the warm air is introduced, at one time from above, at another from below, and alternately at one or the other extremity of the chamber. It is drawn in through the wood and drawn out by a ventilator working at the opposite extremity.

Boucherie's processes, which belong to the first and second groups, utilize at one time the vital osmatic force of growing trees; at another the infiltration of a liquid, or the displacement of the sap by this liquid, on the tree recently felled. In the first case, one or two saw cuts are made at the base of the trunk or several quite deep holes. An earthen band or a strip of cloth smeared with rubber, is placed around the base and communicates by a tube with a small cask containing any antiseptic solution not too concentrated.

The sap on rising in the tree draws with it the liquid, according to the diameter of the capillary vessels. The tree receives the poison as it receives the nutritive element.

In the second case, if the tree is felled, it is placed in a position slightly inclined, and a leather sack, as impermeable as possible, is attached to the trunk and put in communication with a reservoir 10 or 15 millimeters above. The results are quite noticeable, but the process is incomplete, the penetration being irregular, and the displacement of the sap almost *nil* in the heart of the wood.

In the Renard-Perin infecting process, the piece of wood is sawed off at the two ends perpendicularly to its axis. One of the extremities is covered with a sack of impermeable canvas in which the solution is poured; the other extremity is connected with a metallic receiver, in which a vacuum is produced by the combustion of tow soaked with wood spirit, which completely closes the apparatus.

The aspirator bring sfrom the capillary interstices the natural liquids which they contain. These are replaced with the solution under atmospheric pressure. The operation is repeated two or three times.

In general, the processes by pressure in an inclosure, belonging to the second group, are worked by means of cast-iron cylinders containing the pieces of wood. In many cases a vacuum is produced at the outset in the cylinder containing one or several pieces, then the liquid is introduced under pressure for several hours.

A modification of the Boucherie and the Renard-Perin processes is the new process of G. Lebioda & Co.,—the injection of the wood in mass. The trunk or log is inclosed in a

kind of cast-iron autoclave able to support a pressure of 150 atmospheres. The liquid is injected by a pipe under a pressure which is gradually increased for a quarter of an hour in the case of spruce up to 100 atmospheres. The wood is surrounded by the liquid, which is kept at the same pressure as that entering. According to the inventor the fibres of the wood would offer no resistance under this process. The liquid entering would act like steam in the Gifford injector. But, in our opinion, the liquid submitted to so strong a pressure would seek to pass out by the shortest path, and the wood would therefore be penetrated irregularly.

When the object is to dry wood rapidly by this process, the treatment is effected simply with water: the sap, according to the inventors, would be expelled from pieces 10 by 10 centimeters, which would be dried in four days, the temperature of the air of the dryer being gradually raised to 90 deg. C., the temperature at which charring commences on the fibre. As the apparatus used by Lebioda and Co. is more costly than that of the Boucherie and Renard-Perin processes, the results must be similar, the sap contained in the capillary vessels not having time to be completely displaced by the osmose necessary for this exchange of liquids. Under these conditions of rapid treatment, the osmose ceases in the heart of soft woods, and is slight in the whole mass of hard or resinous species.

The superficial carbonization, belonging to the third group, is valuable for hard woods which cannot be impregnated with antiseptic substances. This treatment is of more durable efficacy. The charring is produced by a flaming jet, which in the current of compressed air forms a kind of blow-pipe and causes a strong disengagement of heat. The flame draws out the water contained in the superficial layers, dries the fermentable portions, carbonizing completely the external part, and produces a torrified surface about half a millimeter thick, almost distilled and impregnated with the products of this distillation, which are empyreumatic creosoted substances.

Drying with smoke, which is effected in a chamber of masonry heated by the combustion of moist sawdust, which yields a thick smoke, renders the wood useless for many industries, on account of its disagreeable odour and the slight resistance of its fibres, which have undergone some change.

In fine, of all these processes except that of Nodon and Bretonneau, which we will describe, none resolves in an entirely satisfactory manner the problem of the rapid drying of wood or the complete penetration of antiseptic or fireproofing products. Rapid ageing of wood by electricity of the different processes hitherto employed by Messrs. A. Nodon and A. Bretonneau,

preserving only the best principles and inspired by the experiment of Daniel on the displacement of a globule of mercury by the electric current, have succeeded in utilizing electricity for modifying the constituents of the sap. By that physical force which at times produces such unexpected effects, they have introduced on the ligneous tissue a suitable saline solution, which, after rapid drying, secures for the wood resistance to putrifying agents. Daniel, in his interesting experiment, placed in a glass tube bent at its extremities and arranged horizontally, a globule of mercury immersed in acidulated water. He introduced the wire of a battery at one of the extremities of the tube, the other wire in the acidulated liquid at the opposite extremity, and observed the movement of the globule of mercury, which was displaced from the positive to the negative pole.

After several years of study on the modifications of the vital parts of the wood and on the arrangements to be adopted and the choice of the baths for treating the wood, MM. Nodon and Bretonneau have been able, by placing the wood between two electrodes of lead, to finally resolve the difficult problem of the artificial ageing of wood and fibrous substances. The company which operates this important discovery has erected a model factory at Aubervilliers.

The practical working of this process is quite simple. The apparatus serving for the electric treatment of the wood consists of vats of cement or wood rendered tight by a lead lining 1½ millimeters in thickness and isolated from the bottom electrically by porcelain. The dimensions are 6 metres and 12 millimeters in length, 3 millimeters in width and 1 millimeter in depth. A copper coil, placed horizontally at the bottom of the vat, allows of heating the bath by means of steam brought in by a pipe, which is connected on the outside with the coil by joints, easily taken apart in such a way that the temperature of the saline solution can be kept at about 35 deg. C. during the introduction and removal of the wood, and then isolating the coils and consequently the vat from the steam-pipe.

The wood to be placed in the vats is arranged on the outside on movable platforms, a kind of open work frame covered with lead from 1 to 2 millimeters in thickness, forming the first electrode. The logs may be treated before they are cut up, provided they are separated from the bark. The logs or planks are placed in piles on the platforms as nearly uniformly as possible, the different piles being of the same height, 0·70 at the maximum. The quantity, thus prepared, is raised on a turn-table by a windlass, the platforms having a series of hooks, allowing of their being suspended to an iron frame under the windlass. The wood is then brought over the vat and let down into it The upper face of the wood is covered with the second electrode formed of

lead 1 millimeter in thickness, contained in a connected series of small porous vessels or compartments of wood; these are in size from 0·90 metre to 1·25 metres in length, from 0·75 metre to 0·90 metre in width and 0·10 metre in height; closed at the lower part by felt between two pieces of canvas beaten down and fastened on the sides of the frame under wooden lath kept in place by screws. Thus there is a receiver retaining the water that is poured in for assuring the proper contact of the wood and the lead, as well as of the canvas and the felt, which serve as an intermediate vehicle for the different components of the sap expelled from the wood during the operation. The lead of the different porous compartments is united and thus forms a continuous electrode, which is put in communication with one of the poles of the dynamo, the other pole being connected with the lower electrode.

The vat is then filled with the solution employed for the treatment of the wood. This may be antiseptic or formed of salts for rendering the wood uninflammable. That in use at Aubervilliers for the ageing of wood properly so called is a solution of crystallized magnesium sulphate (80 parts water, 20 magnesium sulphate) heated to 35 degs. C. The wood is immersed in this solution, emerging from the surface only a few centimeters (3 to 8 centimeters), the lower face of the upper piece of each of the piles of wood being always moistened by the solution. This bath may be used indefinitely, provided it is regenerated by means of magnesium sulphate according to the density of the liquid or the percentage of the salt. About every month the bath is brought to the boiling point in order to coagulate and readily separate the organic matters proceeding from the wood.

Before the solution of magnesium sulphate was employed, other baths were experimented with, which were abandoned on account of practical objections, such as the deposit of resinous matter on the surface of the wood, which had to be removed by scraping and washing, or on the fibre itself, which too quickly dulled the tools employed in working the wood.

In the treatment with the magnesium sulphate the continuous current employed is 110 volts, but instead of being directed through the wood always in the same direction, a change is made every hour or every two hours, or half the amount of electric horse-power necessary for the operation is passed from the top to the bottom, and then the other half from the bottom to the top.

The duration of the treatment by electricity is proportioned to the electric resistance of the wood, which varies according to its nature, its thickness and its humidity. As in the processes by injection, the operation is the more prompt and complete, whatever the species of wood, provided it has been recently cut down, that is, if the sap has not undergone modification.

The ageing of wood by treatment in vats is completely terminated when six electric horse-power or about 4500 watt-hours have passed per cubic metre of wood. The time may vary from seven to fourteen hours, the intensity of the electric current being generally kept between four and six amperes, which is secured by increasing or diminishing the emergent part of the wood.

Phenomena produced during the Electric Treatment.—According to Daniel's experiment, electricity produces in the cells of the wood movements of contraction and dilatation.

1. A part of the magnesium sulphate of the solution employed penetrates by electro-capillarity into the cells which are more or less free from the sap.

2. Under the influence of the electric current there is an osmotic exchange between the saline substances of the sap and the magnesium sulphate.

3. Electrolytic action on the ferments of decomposition and putrefaction contained in the wood.

4. Finally, and the most important point, the simultaneous electrolysis of the organic salts contained in the sap and incrusting matters of the wood and the magnesium sulphate. The electricity facilitating the contact of the re-agents with the ligneous fibres, the salts and metallic oxide are deposited and united with this fibrous matter, and fabrics are mordanted by alum. The ligneous fibre containing the phosphates which contribute to this precipitation is thus united and protected from the action of the air :—

By the reversal of the direction of the electric current the acids formed coagulate the albumen, the nitrognized matter being always accompanied with sulphur and phosphorus. The metal unites with these metalloids, and the phosphides and sulphides formed render the nitrogenized matter unfit for vegetable and animal life.

There is therefore a formation in the mass of the wood, under the influence of the electrolysis, of new mineral compounds, stable and imputrescible, and this in a way much more complete than by any other process, preventing the ulterior development of the germs which cause the decomposition of the wood.

The action of the electric current in the process of the ageing of wood is therefore very important. Investigation with the microscope and the results of analysis demonstrate the penetration of the elements of this salt in the fibrous matter to the heart of the wood.

The different parts of the wood being of heterogeneous constitution, the proportions of the elements found by analysis vary

from one point to another. The results given below are the averages of analysis of samples taken from different parts of the same piece of wood.

Ash obtained by incineration: oak not treated, 0·30 per cent.; oak treated with magnesium sulphate 0·90 per cent.; gray poplar not treated, 0·28 per cent.; gray poplar treated with magnesium sulphate, 0·82 per cent. By analysis of the ash of the gray poplar treated with magnesium sulphate, there are found 0·24 per cent. of sulphuric acid, corresponding to 0·60 of crystallized magnesuim sulphate; 0·55 per cent, of magnesia, of which one part (0·10) corresponds to the 0·60 of the magnesium sulphate above, and the rest 0·45 per cent. is in the free state or combined with the organic acids of the wood.

Drying of the treated wood.—After treatment, if the wood is in logs, it is cut up in timber, according to need. After it is thoroughly soaked with water, it is left from 8 to 15 days under a shed for drying. For this purpose the pieces are piled on each other separated by two or more spruce laths, according to length, the thickness of the lath varying from 8 to 25 millimeters, according to the thickness of the pieces.

If sufficient space is at disposal, the wood can be left to dry entirely in the open air; still it undergoes the alternations of heat and cold and the irregularity of the action of the air. It seems, therefore, preferable, after a first drying without, to pile the pieces in a chamber, where a current of heated air is kept in constant circulation from two to eight weeks, according to the thickness, at a temperature gradually increased to 35 deg. or 40 deg. C. The wood is then thoroughly dried and ready for use.

Principal Advantages of the Artificial Ageing of Wood over the process of natural drying.—If a piece of senilized wood and a piece of the same kind not treated and dried simply in the open air are compared under the microscope, it will be observed that the cells of the former have undergone contraction. The entrance of the air will therefore be rendered more difficult. Then the original albumenoid matters no longer existing, the wood will not be subjected to the influences of the hydrometric state of the air, and may be preserved without change, escaping putrefaction and the attack of insects.

These properties have been proved by tests of the resistance, showing an increase of the tenacity of the fibrous matter. Experiments made by the superintendents of wood paving in the city of Paris have attested conclusively the penetration by this process. Pavements of senilized beech and pavements of beech simply creosoted have been laid in several quarters, particularly at the Porte Saint Martin. When taken up some time afterward, the treated beech showed no sign of the usual putrefaction and exhibited more resistance to wear than the beech not treated.

By ageing the colour of the wood is not modified, and its sonorousness is increased to such an extent that it is now sought for by the makers of instruments of music.

This process not only imparts to the wood the qualities that have been enumerated, but causes an important saving over the methods hitherto employed, especially over that of drying in the open air, in the diminution of the capital represented in the value of the wood and in the land occupied and in the prevention of waste.

It is not only applicable to the rapid drying of wood, but it allows of modifying the conditions of treatment, of increasing any one of the qualities previously cited, according to the kind of wood and the use to which it is to be applied; it is to be observed that for wood of close fibre the phenomenon of endosmose is weaker than for wood of loose texture, while the phenomenon of exosmose still preserves its value.

For instance, in ageing wood in a bath of sodium phosphate and borate, the durability of the wood may be augmented. With the aid of zinc sulphate a quantity of salt may be introduced in the fibre of the wood varying with the strength of the solution and the duration of the treatment. A resisting power will thus be imparted to the wood permitting its employment with success concurrently with creosoting for paving railway ties, draught vehicles, telegraph posts, and other purposes.

Finally, by the electric treatment the uninflammability of wood may be increased by employing, for example, ammoniacal salts.

Fireproofing of Wood.

Strictly speaking, it is impossible to render wood completely incombustible, but an almost absolute immunity against the attacks of fire can be imparted.

Gay-Lussac was one of the first to lay down the principal conditions indispensable for rendering organic matters in general and wood in particular uninflammable.

1. During the whole duration of the action of the heat the fibres must be kept from contact with the air which would cause combustion. The presence of borates, silicates, etc., imparts this property to organic bodies.

2. Combustible gases, disengaged by the action of the heat, must be mingled in sufficient proportion with other gases difficult of combustion, in such a way that the disorganization of bodies by heat will be reduced to a simple calcination without production of flame. Salts volatile or decomposable by heat and not combustible, like certain ammoniacal salts, afford excellent results.

Numerous processes have been recommended for combating the inflammability of organic tissues, some consisting in external applications, others in injection under a certain pressure of saline solutions.

By simple superficial applications only illusory protection is attained, for these coverings, instead of fireproofing the objects on which they are applied, preserve them only for the moment from a slight flame. Resistance to the fire being of only short duration, these coatings scale off or are rapidly reduced to ashes, and the parts covered are again exposed. It often happens, too, that such coatings have disappeared before the occurrence of the fire, so that the so-called remedy becomes injurious from the false security occasioned.

We will cite some formulas still recommended. They are applied :—

1. By immersion or imbibition.
2. By application of successive coats by means of a brush.

1. For immersion or imbibition the following solution is advised: Ammonium phosphate 100 grammes; boracic acid 10 grammes per litre, or ammonium sulphate 135 grammes; sodium borate 15 grammes, boracic acid 5 grammes per litre. For each of these formulas two coats are necessary.

2. For application with the brush the following compositions are the best.

(*a*) Apply hot sodium silicate 100 grammes, Spanish white 50 grammes, glue 100 grammes.

(*b*) Apply successively and hot, for first application, water 100 grammes; aluminium sulphate 20 grammes: second application, water 100 grammes; liquid sodium silicate 50 grammes.

(*c*) First application, two coats hot: water 100 grammes; sodium silicate 50 grammes: second application, two coatings: boiling water 75 grammes, gelatine white 200 grammes; work up with asbestos 50 grammes, borax 30 grammes and boracic acid 10 grammes.

Oil paints rendered uninflammable by the addition of phosphate of ammonia and borax in the form of impalpable powders incorporated in the mass, mortar of plaster and asbestos and asbestos paint, are still employed for preserving temporarily from limited exposure to a fire.

In England, America and Paris attempts have been made to introduce under strong pressure, preserving solutions into fibrous substances. Even large establishments have been erected in different countries for this purpose. Unfortunately this process by

pressure is still attended with the serious evil of introducing fireproofing products only in the outer part of the wood; the solution reaching but a quite a limited depth. The process consists in removing from the wood with the aid of steam under pressure, a part of liquid products which it contains which excites a sort of distillation of the inflammable products, for which solutions are substituted, generally composed of ammonium sulphate or phosphate, boracic acid or alkaline borate.

The best result has been obtained by the electric penetration of the salts. In the Nodon and Bretonneau process fireproofing products have been introduced through the whole mass of the wood, and this in a way much more regular than by injection even under strong pressure. A power of resistance to the attacks of fire truly exceptional has been thus imparted. The quantity of fireproofing products depends on the concentration of the bath and the duration of treatment.

It has been ascertained by experiment that wood is really uninflammable; that is to say, that it resists for quite a long time a very high temperature, if it contains according to its nature, from 15 to 20 per cent. of the salts employed.

FIREPROOFING OF WOOD BY ELECTRICITY.

The successive operations and the apparatus for incorporating the fireproofing salts in the mass of the wood are nearly the same as those for the ageing of wood properly so-called. It is absolutely necessary for the treatment that the wood should be both green and not too hard. The penetration of the salts being effected in great part by osmose, the sap is an important factor; and a hard wood would be difficult for the introduction of a quantity of preserving substances.

The vats employed are on the average 4·50 metres long, 1·50 metres wide, and 0·70 metre deep. They may be of cement or of wood lined with lead, like those used for ageing with magnesium sulphate, but the solution of ammoniacal salts is heated by a worm of hardened lead, instead of copper, in which the steam circulates.

At each of the extremities of the vat is a vertical partition of lead perforated with holes, forming a kind of reservoir, 0·25 metre wide by 1·50 metres long (the width of the vat), in which are poured the fireproofing salts necessary for maintaining the solution at saturation.

The wood is piled upon the lower electrode to a height of 0·15 metre to 0·20 metre at the maximum, and covered with porous vessels containing the second electrode. The fireproofing bath employed is a saturated solution at the temperature of 80 deg. C. of ordinary ammonium sulphate and ammonium borate.

The electromotive force of the electric current utilized ought not to exceed 25 volts. The electricity passes into the wood always in the same direction from below upward.

According to numerous tests which have fixed the constants of the electric treatment, the best results are obtained with an intensity not exceeding 12 to 16 ampères per stere of wood; that is to say, that the electric energy necessary is about half an electric horse-power per stere in treatment.

The total duration of the operation is 48 hours, divided into two equal parts. At the end of the first period, the wood is reversed (turned upside down). The wood thus treated has absorbed from 15 to 20 per cent. of its weight of the salts of the bath. These salts penetrate to the heart of the cells and form a sheath around the fibre. If the wood after drying is submitted to the action of fire, the ammoniacal salts, which encompass the fibres, melt. On increase of the heat, the fibrous matter is carbonized slowly and the gaseous products resulting from the decomposion of the salts prevent the ignition of the combustible products proceeding from the calcination of the fibre. In a word, the fire is limited to the points attacked and is not propagated to the neighbouring fibres.

The official tests conducted at Paris by the fire department are conclusive. On the application of the officials the inventors constructed a number of cubic boxes, 0·50 metre in size of spruce and poplar fireproofed planks 26 millimeters in thickness; the bottoms of the boxes were perforated with five holes. One of the boxes was filled with a kilogramme of dry shavings, which, when set on fire, required five minutes for consumption. A large amount of heat was developed. After the combustion it was found that the outside walls of the box had remained cold, and that the inside had not been charred beyond the thickness of 1 millimeter. No point remained on fire and no part of the wood was separated under the influence of the extreme heat.

The second box contained a double weight of shavings which were thirteen minutes in burning. When the combustion was completed it was found that the interior of the box was red with heat, but without flame.

The third experiment took place with a fireproofed box of white wood, in which three kilos of shavings were burned. The test lasted for 30 minutes, the interior was incandescent and the wood charred for five or six millimeters in depth, while the exterior was simply heated.

Another test with a spruce box not fireproofed containing 1 kilogramme of shavings ended in three minutes in a small conflagration, which had to be extinguished with water. These results are conclusive.

A piece of fireproofed wood submitted to the action of the electric spark is simply carbonized at the parts of contact, while wood not treated bursts quickly into flame.

The curious tests on the resistance of certain building materials to fire, conducted before the representatives of foreign fire departments, may also be cited. A square construction of cement was filled with 7 or 8 steres of wood moistened with petroleum. It was furnished on one of its sides with an iron door, on its second side with a door of wood fireproofed by this process, and on the third with a window of protected glass, that is, glass cast on metallic gauze. Wood piled up in this enclosure was set on fire and extinguished after the interior temperature had reached about 1400 deg. The door of wood was consumed only after the lapse of one hour.

The iron door was very quickly put out of shape and allowed such a quantity of heat to pass that ordinary boxes placed at a distance of three metres were consumed.

This method of penetration furnishes complete security in other extreme exposures. The wood designed to receive electric wires may, by being previously fireproofed, avoid the serious accidents which frequently occur.

Wood thus rendered incombustible is imputrescible, its tenacity is the greater, but it can be readily worked. It can be glued perfectly and receive the painting or varnishing desired for preventing the penetration of the moisture of the air and avoiding completely the decomposition of the ammoniacal salts.

This new method of rendering wood incombustible, while materially augmenting its value, does not involve too large an expense. Experience, indeed, has shown that the cost of fireproofing by this process is less than that of other methods in use, and that the wood can be employed for numerous purposes, especially on war vessels, where metal has been hitherto used.—*Translation in the Scientific American Supplement from the Revue de Chémie Industrielle.*

VII.—TIMBER AND PRODUCE TRADE.

Churchill and Sim's Wood Circular.

4th November 1902.

East Indian Teak.—The deliveries in October consist only of 501 loads, against 1,416 loads in October, 1901. For the last ten months they amount to 10,481 loads, against 11,996 loads for the same periods last year. The market has been rather lifeless during the month, and it is difficult to get prices here commensurate with

those justified by the lack of supplies at the shipping ports consequent on want of water. Some partial improvement has been experienced in this latter respect according to recent reports. There has been a fair demand for planks at satisfactory rates.

ROSEWOOD, EAST INDIA.—The present small demand is amply covered by existing stock.

SATINWOOD, EAST INDIA.—Plain wood is of slow sale, but for finely-figured logs good prices are obtainable.

EBONY, EAST INDIA—is in steady demand, provided the wood is of fair sizes and in good condition.

PRICE CURRENT.

Indian Teak, logs, per load	...	£10 5s to £18 10s.
,, ,, planks ,,	...	£13 5s. to £20.
Rosewood, per ton ...	...	£7 to £10
Satinwood, per s.ft. ...	...	5d. to 12d.
Ebony, per ton ...	...	£9 to £12

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The Insect World in an Indian Forest and how to study It.

BY E. P. STEBBING, F.L.S., F.E.S.

(*Continued from p. 18.*)

PART V.

THE ORDER *COLEOPTERA*.

THESE appear to be wingless insects, but have really four pairs of wings. The upper pair, which are called the 'elytra,' are hard and horny and shell like, fitting accurately together over the back, thus protecting it and the lower wings, which are folded beneath them and are membranous. In the mouth mandibles are present, and the lower lip is divided along the middle. The metamorphosis is complete. The larva is grub-like, and changes to a pupa in which all the parts of the perfect insect are distinguishable, but are still white and soft.

Coleoptera are one of the largest and most important of the Orders of Insects as well as being one of the most injurious in the forest. Both larvæ and imagoes bore into timber (and also into the roots) and lessen or destroy its value. They also girdle branches and kill them, feed upon and defoliate the leaves, and burrow into and destroy the seed.

Beetles are chiefly distinguished from other insects by the solidity of their outer covering and by the peculiar nature of their first pair of wings, which are not used as instruments of flight, but merely serve to protect the hinder part of the body. Beetles are not found on the wing as much as other insects, and therefore, notwithstanding their enormous numbers, they are not met with so frequently as ants, bees, flies, etc. The number of species at present known is probably about 150,000, and their habits are so varied that they can be found everywhere when looked for. The general form varies much from flat-spherical to long-linear. The

head is well developed, with a biting mouth; compound eyes are present, which are not uncommonly divided. Ocelli (simple eyes) are rare. Antennæ eleven-jointed or with fewer joints. These latter are variable in shape and are of importance in classification. When the elytra are shut up, they cover the greater part of the meso- and meta-thorax, abdomen, and the lower wings. At the top there is a triangular portion called the scutellum, which forms the upper part of the meso-thorax. The elytra may leave a few of the lower segments of the body exposed. These elytra are of such importance to the beetle that they are even present in cases where there are no lower wings. When this occurs they are often joined together down the central suture so as to form one piece, though the line representing the junction is always present. When a beetle flies, the elytra open slightly upwards, letting free the lower wings. In the common rose-chafer (the green metallic looking flat beetle to be found upon roses), where the elytra are joined together they are merely lifted up; when the elytra are absent, as occurs in some beetles, there are no lower wings present. The nervures or veins in the lower wing are broken up to allow of their being folded up under the wing covers. The number of tarsal joints present varies from 2—5. One may be hidden and is only seen on dissecting. For classification purposes only those visible are counted. Some of the tarsal joints may be bi-lobed; they are set with a spongy felt-work of hair to help the insects to walk up on plants. Only 5—6 segments of the abdomen are visible. There is often a considerable difference in the sexes amongst beetles. There may be either an increase in size of the antennæ in the males or an enlargement of the interior tarsi; occasionally the number of joints of the tarsi vary in the two. The only music produced is chirping or squeaking by rubbing two files together. Phosphoretic organs are present in glow-worms and fire-flies. These consist of masses of cells connected with a fatty body and are freely supplied with air. The light produced is caused by the oxidation of proteid matter. These organs are situated on the abdomen. The larva is grub-like, with a distinct head and jaws; sometimes antennæ and six legs are present. They have no special boring apparatus and the sexes are distinct. They usually feed at night and upon all sorts of substances. They are sometimes parasitic upon other animals, but this is not usual. The pupa is quiescent and usually enclosed in a rough cocoon. The adult may live near the cocoon for some time after emergence without movement, whilst its outer layers of chitin are slowly hardening (this will be found common amongst the bark borers, *Scolytidæ*). The beetle when found in this condition under the bark is yellow or light brown in colour, changing to dark brown or black before it finally emerges from the tree.

Coleoptera are classified according to the number of tarsal joints present, into four great groups, and these groups are again divided into series as follows:—

Pentammera—5 tarsal joints present upon all the legs.	Series, Lamellicornia—Antennæ with the terminal joints broader on one side so as to form a peculiar club, the leaves of which are movable. Series, Adephaga or Caraboidea—Antennæ filiform or nearly so. Series Clavicornia—Antennæ usually thickened at the tip or knobbed. Series, Serricornia—Antennæ usually serrate along their inner edge.
Heteromera—1st and 2nd pairs of legs have 5 tarsal joints; the third pair have 4 only.	The families Tenebrionidæ and Cantharidæ only will be considered here.
Tetramera—4 tarsal joints present on all legs.	Series, Phytophaga—Head not forming a definite prolonged beak. Series, Rhynchophora—Head more or less prolonged in front to form a snout or beak (rostrum)
Trimera—3 tarsal joints present on all legs.	The family Coccinellidæ only will be considered here.

PENTAMMERA.

5 tarsal joints on all the feet.

Lamellicornia.

Tarsi five-jointed; antennæ with the terminal joints, called *lamellæ*, usually three in number (sometimes more), broader on one side, forming a club, the leaves of which are movable, but in repose look like one piece, as they are held close together. The families *Passalidæ*, *Lucanidæ*; and *Scarabæidæ* are included here; the form of the leaves of the club of the antennæ varies in shape in these three families. The larvæ live in decaying vegetable matter, roots, or dung. They have a horny head, large jaws and three pairs of legs, and are thick clumsy grubs with curved bodies, the last two segments being of larger size than usual and often swollen out in a bag-like manner.

Family Passalidæ.

The upper lip is large and mobile and the mentum is deeply cut out in the middle. The antennæ curl upwards and the plates at the top are thus brought together. These beetles are usually shining black in colour and are abundant in decaying wood in tropical forests. The larvæ appear to have only four legs, the first pair being short processes which are used to produce sounds by scraping over striated surfaces on the next pair. Very little is at present known about these insects in India.

Family Lucanidæ (Stag-Beetles).

The stag beetles are well known owing to the enormous horns present. These horns are only greatly developed mandibles, and are only present in the male beetle. Upper lip is small and the mentum is not cleft. The antennal end consists of a fixed

cone, which is rigid and does not open and close. The male is usually larger than the female. Five ventral abdominal segments are visible. The larva has the last two segments of its body swollen up in a bag-like manner, and lives in decaying wood and roots, spending several years of its existence in this stage. The pupal stage is a short one, but the perfect insect may remain quiescent some time after leaving the pupa before it becomes active.

In the outer Himalayas the mature beetles are to be found in June and July. It is probable that they issue irregularly during the summer months, as the writer has found fully-developed larvæ just pupating and also mature beetles in July. Some years ago Lucanid larvæ were reported as tunnelling into green living oak trees in Naini Tal. Owing to their queer swollen bag-like extremities it is extremely inprobable that these larvæ are capable of tunnelling into green hard wood. It is probable that if boring was done in hard oak timber, longicorn larvæ were responsible, and the stag-beetles may have taken advantage of the galleries to lay their eggs in the ones whose edges were rotting and thus becoming softer. The writer has found numerous instances of decaying oak, etc., stumps being full of these larvæ but no instance of hard green wood being infested.

Family Scarabæidæ (Chafers).

The leaflets of the antennæ are freely-movable plates, which can be closed together at will by the insect. The number of visible ventral segments is usually six or at the sides seven, never five as in the last two families. The elytra generally leave one or two of the last segments of the body exposed. The beetles of this family are bulky insects, having a powerful prothorax and front legs with flattened spiny tibiæ adapted for digging. Both larvæ and adults feed upon plants and dung. The family is an important one amongst insects. About 13,000 species are already known. At times the males are armed with horns of various shapes growing out of the head and prothorax. Several sub-families are distinguished.

The *Coprides* or dung beetles live as larvæ chiefly on the dung of the ungulata; they form the dung into balls, which they roll along by means of their hind legs or by pushing with their head until they have reached a suitable place; they then dig a hole and push the ball in and get in themselves and feed upon it. Later on they dig another hole, fill it with dung and lay their eggs in this and close up the aperture. The young larva on hatching out feeds upon the store thus provided. They are thus useful insects, as they act as scavengers.

The *Melolonthides* include the cock-chafers. The larvæ of these beetles feed upon roots, often doing a great deal of damage, whilst the beetles live upon leaves. The larval life extends often over several years, during which time the grub grows in size and feeds voraciously, living underground and only coming to the

surface at night. The pupal stage is very short, but the adult may remain a long time in the ground after leaving the pupa before emerging from the soil. The ♂ can be recognised from ♀ by the larger lamellæ on the antennæ. In India a species of cock-chafer, *Melolontha vulgaris*, has been reported as doing immense damage in flower gardens, vegetable gardens, and tea gardens, where it is known as the 'white grub.' This species does not, however, appear to have been yet reported as causing injury in nurseries. Recently (July 1901) larvæ of a large species of cock-chafer were found by the writer seriously damaging young deodar seedlings, which had been planted in patches in the Bashahr Division in the Punjab. The beds were riddled with holes, out of which portions of young green deodar seedlings were seen protruding. Seedlings bitten off at their bases were also found lying on the bed withering up Three to four inches down in the soil large yellowish-white cock-chafer grubs were found.

The *Dynastides* include the large bulky beetles whose males have enormous projections and horns on there heads and prothoraces, the use of which is not at present understood. Members of the family are common in India. The large Goliath beetle (*Oryctes rhinoceros*) also called the Rhinoceros beetle, belongs to the *Dynastides*. It lives in cocoanut palms, and injures them by cutting holes in the developing shoots and burrowing downwards This insect has proved excessively destructive in Kanara and the Madras Presidency. Its larvæ are to be found in heaps of rotting vegetable matter. Such heaps should never be allowed to accumulate in the neighbhourhood of the cocoanut trees.

The *Cetoniides* include the rose-chafers, the small, brightly-often metallic-coloured beetles which are to be found upon rose bushes.

ADEPHAGA OR CARABOIDEA

Tarsi five-jointed, antennæ filiform or nearly so. Mouth parts highly devoloped with slender projecting mandibles; ventral segments of abdomen visible usually five in number. Active, slim dark-coloured beetles, with long powerful legs, all of whom, including their larvæ, are carnivorous. The larvæ are usually dark-coloured. with a group of ocelli on each side and with well developed legs each with two claws, only one claw is present in all other coleopterous larvæ.

FAMILY CICINDELIDÆ (TIGER BEETLES).

Bright-coloured beetles with large eyes and with the clypeus (lower part of front of the head) extending laterally in front of the insertion of the antennæ, the latter being long and straight. The mandibles are large and are set vertically instead of horizontally. The elytra are often spotted.

This family includes some of the most active and most carnivorous of the beetles. They feed upon insects of all kinds. The larvæ live in burrows in the ground, where they lie in wait for

their prey. A species named *Cicindela punctata* has been reported as destructive to the rice sapper, *Leptocorisa acuta*, a destructive pest in the rice fields. Investigation will doubtless show that species exist of use in keeping down forest pests.

FAMILY CARABIDÆ (GROUND BEETLES).

These beetles resemble the *Cicindelidæ*, but the mandibles are set horizontally. They are usually blue or black in colour and are carnivorous in their habits. A species named *Calosoma orientale* attacks and preys upon the young of the locust *Acridium peregrinum*, destroying them in large numbers. Several other species are very common in India. The writer noted that a large Carabid beetle with cream coloured blotches on its elytra feeds upon the larvæ of the hawk moth *Pseudosphinix discistriga*, which defoliate the teak in Berar during the rains.

Note.—The water beetles, *Dytiscidæ*, and the whirligigs, *Gyrinidæ*, seen swimming in circles on the surface of pools and streams in the sunshine belong to this series, but are unimportant.

CLAVICORNIA.

Tarsi usually five-jointed. Antennæ thicker at the tip or knobbed. All the parts of the insects in this group may vary, exceptions being numerous.

Some of the insects of this series are kept by ants in their nests.

Many flat clavicorns feed under bark on the sap of the tree. A species feeds in this way under the bark of sal trees and another is to be found amongst bark boring beetles under the bark of the blue pine (*Pinus excelsa*). These beetles should not be confused with the true bark-borers.

FAMILY SILPHIDÆ (CARRION BEETLES.)

Antennæ clavate or at least flattened at the tips. In some forms the elytra cover the whole of the abdomen: in others its tip is left uncovered. These beetles are as a rule carrion-feeders. The genus *Silpha* has slightly clavate antennæ, elytra covering the whole of the abdomen and the body of a flat oval form. The larvæ are broad and flattened and find their own food, that is, it is not stored up for them by the parent beetle. Both larvæ and adults feed on dead animals. The burying beetles (*Necrophorus*) have markedly clavate antennæ, elongate bodies and short elytra, usually coloured in red and black bands, leaving the hinder end of the body uncovered. Several generally unite to bury small mammalia, etc., removing the earth below the carcase, in which they lay their eggs. The larvæ are pale and large, possessing legs and eyes; they feed upon the carrion buried by their parents. These beetles may be seen in the forest at work in this way.

FAMILY STAPHYLINIDÆ (ROVE BEETLES).

These beetles are distinguished by the small size of the elytra; the larger portion of the abdomen, which is very movable, is not covered by them, but is covered by a thick layer of chitin on its dorsal surface. The hind wings are folded under the elytra. The body is elongate and antennæ filiform. The adult generally lives upon decaying plant and animal substances. The larvæ are like those of *Carabidæ*, but have only a single claw on each foot. They have two-jointed cerci at the end of their bodies. They feed either like the adults or are predaceous. Numerous mature beetle forms, believed to be predaceous, have recently been found by the writer in the tunnels of bark or wood boring *Scolytidæ* in deodar, spruce, and blue pine, etc., and it is probable that the family will be found to be of considerable forest importance in this respect.

FAMILY HISTERIDÆ.

Compact beetles with hard integument, often shining, and short, bent antennæ ending in a compact club; elytra leave two segments of the body exposed. Abdomen with five visible ventral segments; hind coxæ are widely separated.

These beetles are common in dung, in carcases, decaying fungi, etc., and some live under bark, these being often very flat insects. Some are small cylinders, constructed for entering the burrows of insects boring into wood. It has been for some time believed, and the writer has been able to verify the fact in several instances quoted below, that these insects are predaceous and feed upon the larvæ and adults of boring beetles. Some live in ants' nests, probably devouring the larvæ. A few species live in company with Termites.

From observations made during the last few years the writer is of opinion that members of this family play an important part in keeping down the numbers of wood-boring and bark-boring beetles of the families *Bostrichidæ* and *Scolytidæ*. Species of Histerids (*Teretriosoma*) have been found in the tunnels of the bostrichid wood-borers *Sinoxylon crassum* and *S. anale*, whilst numerous others have been found in the galleries of newly-discovered bark-borers of the genera *Scolytus*, *Polygraphus*, *Hylesinus*, *Tomicus*, etc.*

FAMILY NITIDULIDÆ.

Antennæ have a three-jointed club; all the coxæ are separated, and each has an external prolongation; tarsi five-jointed, the fourth joint being smaller than any of the others; abdomen with five visible segments. The habits of these beetles are very varied; some live under flowers, others in the bark on the sap of trees, others again in carcases. One larva causes much loss by living in the flowers of mustard (rape) and prevents the seed

* See Departmental Notes on Insects that affect Forestry, Nos. 1 and 2.

forming. It pupates in the ground. Another one feeds upon turnips. Many Indian forms will doubtless be found feeding upon the sap of trees on newly-cut stumps, etc., and should not be confused with bark and wood borers.

Family Trogositidæ.

These beetles resemble the above family. Some are of fair size. They are predaceous and destroy the larvæ of other insects in large numbers. One species has been found predaceous upon bostrichid beetles which were attacking *Terminalia tomentosa* posts.*

Family Dermestidæ.

Small beetles with clavate antennæ and deflexed heads; the surface of the body is covered over with small close-set hairs. The beetles and their larvæ feed upon dead animal substances, such as skins, etc., and are often very injurious to the latter. The larvæ and beetles issuing from a newly-shot skin that has been left untended for a few days are *Dermestidæ* and will not unlikely be the common species *Dermestes vulpinus*. When full fed the larvæ hide themselves away, sometimes burrowing into hard wood. They do damage in museums and to stored hide goods, boots, etc. To protect saddlery, etc., when stored away, from such pests the articles should be placed in tin-lined boxes and plentifully besprinkled with napthaline before the case is sealed up.

Serricornia.

Antennæ usually serrate along their inner edge. Other characters may be variable.

Family Bostrichidæ (Bark and Wood Borers).

Antennæ straight, often lamellate at the top. Tarsi five-jointed, but the first joint is very short; front coxæ are prominent and contiguous and extend very little transversely; five ventral abdominal segments are visible. The prothorax is often furnished in front with protuberances, and the elytra behind may be truncate and furnished with small spikes. The larvæ are white, have three pairs of legs, and have the posterior part of the body incurved. These beetles attack dry wood in which they lay their eggs, the larvæ on hatching out also feeding upon the wood. The insects are at times present in such numbers that they entirely riddle and destroy the timber they infest. One or two members of the family have already proved to have a wide range in India, such, for instance, as several species of *Sinoxylon* in the wood of broad-leaved trees and of *Dinoderus* in bamboos. *Sinoxylon crassum* and *S. anale*, both of which have a wide distribution in the country, do considerable damage to wood stacks in the Changa Manga plantation, and these beetles will always

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* *Vide* 'Insect Life in a Terminalia Post' in the *Indian Forester*, Vol. XXVIII, No. 8.

have to be reckoned with in fuel and wood depôts in India. The life-history of *S. crassum* is as follows:—At Changa Manga this beetle makes its first appearance in the year about the beginning of April and burrows into the Sissu fuel stacks, consisting of the wood cut over between the previous November to March; this wood is collected and stacked upon the adjacent compartment lines to allow the fuel to dry. Eggs are laid by the beetles, which hatch out into small white grubs within a few days. The larvæ feed entirely in the wood and take about six weeks to become full fed. Beetles from these larvæ emerge from the wood in July and at once lay the eggs of another generation in suitable wood, these eggs giving rise to the second generation of the beetles in September-October. These beetles hibernate as such in the wood through the winter. In warmer parts of the country there are probably at least three generations of this pest in the year. *S. anale* will attack drier wood than its companion, and has probably a greater number of life cycles in the year.*

Protection.—Keep the coupes as clean as possible and remove all cut wood before April from the neighbourhood of the forest.

Two species of *Dinoderus*†, *Dinoderus pilifrons* and *D. minutus*, are common bamboo pests. They will not attack the green standing bamboo, but as soon as it is felled, if unprotected, it will be riddled by the *Dinoderus* beetles. These borers act in much the same way as already described above for the *Sinoxylon* and have several generations in the year, They are both widely distributed in the country, *D. minutus* being practically cosmopolitan in tropical regions.

Protection.—As soon as felled, bamboos—and this applies equally to poles—should be either kept under water for a few weeks or smoked so as to dry them quickly.

FAMILY PTINIDÆ.

Tarsi five-jointed, the first joint not reduced in size, often longer than the second; five visible ventral segments. The prothorax is often hood-like and often covered with rasp-like projections, and there are several species the posterior end of the body of which may be truncate. Boring is done in both the grub and beetle stages. Two sub-families, the *Ptinides* and the *Anobiides*, are included here. The *Ptinides* are sometimes destructive to dried animal matter and attack museum specimens. The *Anobiides* bore into wood and apparently spend a very short time in the adult stage. Their larvæ resemble those of the last family.

The so-called cheroot 'weevil' (*Lasioderma testaceum*) and the biscuit weevil [*Anobium* (*Sitodrepa*) *paniceum*] belong to this family. The cheroot weevil runs through a large number of

* *Vide* Departmental Notes on Insects that affect Forestry, No. 1, pp. 12-18.

† *Vide* 'Injurious Insects of Indian Forests,' pp. 42–45. Departmental Notes on Insects which affect Forestry, No. 2, pp. 168–175.

generations in the year. To get rid of this destructive insect from a tobacco store, the only plan is to burn all infected stock and thoroughly cleanse out all godowns.

FAMILY MALACODERMIDÆ.

Beetles with very soft bodies and elytra; the prothorax is generally broad and shield shaped, and the head may be hidden beneath it. The elytra are soft and leathery, and are not rigidly attached to the body. They do not meet in a hard and fast suture in the middle, and often leave several body segments exposed. Eyes are large; seven visible ventral segments of the abdomen are present. The females are often wingless. The family includes the *Lampyrides* or glow-worms and the fire-flies (*Luciola*). The larvæ are supposed to be carnivorous, but little is known about them in India. The phosphorescent apparatus is placed ventrally at the posterior end of the abdomen. In the glow-worms the ♀ is wingless and her light is much more powerful than that of the male and may serve to attract him. In the fire-flies both males and females have wings and the light is more powerful in the male than in the female.

FAMILY CLERIDÆ.

This family contains beetles of varied form and colour. The antennæ are usually more or less club shaped at the tip and not at all serrate. The tarsi are five-jointed, but the basal joint of the hind tarsus is very short and the apices of joints two and four are usually prolonged into membranous flaps. The insects have in some instances a superficial resemblance to small longicorn beetle (*Cerambycidæ*). The *Cleridæ* are exceedingly predaceous and their larvæ are very active, being especially fond of wood and bark boring grubs. Observations have led the writer to form the opinion that members of the family are of the greatest service to the Forester in India owing to their predaceous habits. A species of *clerus*, probably closely allied to the European *Clerus formicarius*, is predaceous, both in its larval and imago stages, upon various wood and bark boring beetles in the coniferous forests of the North-west Himalayas. The following is what is at present known upon the life-history of this insect*:—

The larva is an elongated, flat, pink-coloured grub with a brownish head, well-marked black mandibles, and the last segment of the body terminating in two small black processes or points. The beetle is an active bright-coloured insect with an ant-like black head and prothorax, whilst the elytra are red at their bases and black anteriorly, the black being crossed by two white wavy bands. The abdomen beneath is bright vermilion in colour. The insect is half an inch in length. The beetles are to be found plentifully in June, July, either on the wing or runnning actively about on

* See Departmental Notes on Insects that affect Forestry, No. 2, p. 214.

the bark of coniferous trees (also oaks to a certain extent) such as deodar, spruce, blue pine, etc., searching for bark beetles. As these latter emerge from, or settle upon, the bark of the trees, the Clerids seize and devour them, only the harder portion of the chitinous exterior being rejected. Inside the tree in the galleries made by the bark-boring beetles and their larvæ in the cambium and sapwood are to be found the pink larvæ of this clerid engaged in feeding upon the bark-borer grubs. It is probable that the predaceous beetle lays its eggs in the entrance holes of the boring beetles, and the young grubs on hatching out find their way down the entrance tunnel into the egg and larval galleries of the bark beetle. Larvæ of various sizes have been found in the tunnels between May and October, and it is not improbable that there are several life cycles in the year overlapping each other, and that consequently the beetle is to be found on the wing in the forest during these months. The insect is polygamous and excessively voracious. The writer has observed it to feed upon one or more species of the genera *Scolytus*, *Polygraphus*, *Pityogenes*, *Tomicus*, *Hylastes*, *Rhyncholus*, *Diapus*, and *Platypus*, all bark or wood boring members of the families *Scolytidæ** and *Platypodæ*. All these latter beetles have been recently discovered in the North-west Himalayan forests and are new to science. They will be described shortly later on in this part.

The importance of the discovery of this Clerid is evident when it is remembered that *C. formicarius* is known to be of the greatest importance in keeping down bark beetles in European continental forests. So great is the value attached to the beetle that in 1892 a specialist was deputed from America to import it into that country in the hopes of bringing down to normal proportions some devastating bark-boring beetle attacks.

Family Elateridæ (Click Beetles).

Small beetles with a much sunk head and a square prothorax which finishes behind in two points. Legs bristly, short, and very rigid. The prothorax is prolonged on the under side into a spine which fits into a pit in the mesothorax. This arrangement is to enable the insect to jump up into the air when on its back and so turn over again. When the prothorax is raised, the spine is supported against the edge of the depression, and on its being allowed suddenly to shoot back into the pit, the insect strikes the ground with considerable force and is thus jerked up into the air. The click they make in this movement gives them their name of click-beetles. The grubs are called 'wire' worms. They are long, thin and hard and consist of twelve segments with a flattened horny head and three pairs of legs. The head is dark brown and the twelve remaining segments yellow to yellowish brown. They can be distinguished from millipedes in possessing only three pairs of legs, whereas the latter have two pairs of legs on each segment.

* *Vide* Departmental Notes on Insects which affect Forestry, No. 2.

Some members of this family are quite harmless, since they only devour decaying vegetable matter, either in humus or in the rotting substance of dying trees where they are often to be found. Many elaterid larvæ, however, are destructive as root-feeders, and it is in the forest nursery and in areas sown or planted up in patches where trouble may be expected from these pests. The grubs are very active and destroy much more than thay actually devour, moving from plant to plant and cutting through the roots below the surface of the soil. In this way they may destroy whole lines of young plants in a nursery. The larvæ live for several years in the ground and probably feed during most of the time, growing to full size very quickly and spending the rest of the time as a full-grown grub. Though constituting a serious pest in European forests they have not been reported in this connection in India. Recently, however, the writer has found wire-worms present at the roots of young deodar plants which had been sown in patches and at those of a dying young sweet chestnut which had been imported from England. In both cases, which occurred in the North-west Himalayan forests, an inspection of the roots showed that the dying condition of the young plants was probably due to the elater grubs. This family and the damage they are capable of doing should be borne in mind when seedlings are seen to be dying in the nursery without any visible cause to be seen above ground.

Family Buprestidæ.

These beetles resemble the *Elateridæ*, but they have not the jumping apparatus, the pro- and meso-thorax being firmly united. The beetles are often very brilliantly coloured with metallic colours. The lower wings are often the same size as the elytra; the antennæ are typically serrate. The larvæ are soft and white with a horny head which is retractile, and an enormous prothoracic segment. They have no legs. The segments of the abdomen are much narrower than the prothorax, and by this these larvæ can be always distinguished from longicorn ones, which they otherwise closely resemble. They usually live upon wood and do damage by attacking newly felled timber, in which they bore large winding flat galleries. Healthy trees are generally safe from these attacks, but the moment a tree becomes sickly and weakened from any cause, buprestid beetles at once lay their eggs in the bark and the larvæ bore into the wood. These insects are numerous in India, but little information has as yet been collected on their life-histories. Most trees will be found to be subject to their attacks. The larvæ of a yet undescribed species are invariably present in deodar bark, which has been attacked by the bark-boring Scolytidæ, and the rule applies to the spruce and blue pine. In each instance the buprestid comes in later than the bark-borer. There is a small buprestid to be found commonly in the branches of the sal, it taking about a year to pass through one life cycle.

Progress in the United States.

How is it that the States have made more moral progress in Forestry as a cause in ten years than India has done, or will do, in a century? There are various reasons, but the fundamental one is that the President, Congress, and an increasing section of the people *mean* Forestry, whereas in India the progress of the Department has been a continual struggle with the people and often with local authorities. The other important reason is that the people there are educated enough to conviction.

I have been favoured with copies of *Bulletins* 32, 33, and 34 of the U. S. Department of Agriculture, and they have given me a pleasure which I wish to share with others.

Bulletin No. 32 is "Working Plan for Forest Lands near Pine Bluff, Arkansas," by F. E. Olmsted, Field Assistant, Bureau of Forestry, published under the direction of Gifford Pinchot, Forester. Some of us will remember Mr. Olmsted's visit to this country, and the interest with which he studied our forestry. The "Working Plan" is illustrated with 19 half-tone blocks from photographs of the forests concerned, and several diagrams. It is not at all drawn up on the lines of Indian Plans, for it only occupies 48 pages royal octavo, but it appears to be none the less a sound and practical plan. It is divided into two parts. Part I comprises a general description of the forest, the markets, taxes, transport, lumbering, fires, grazing, etc., with short sylvicultural notes on the more important species. These are, shortleaf pine, loblolly pine, cow-oak, white-oak, sweet gum, whit eash, shag bark, hickory, holly, and hornbeam. The forest consists of pine ridge, pine flats, and hardwood bottom, the two former covering 85 per cent of the total area, which is about 100,000 acres unsurveyed, belonging to the Sawyer and Austin Lumber Co. The crop is mixed throughout, but in the pine lands the shortleaf pine forms about 35 per cent. The loblolly forms only about 18 or 20 per cent., and is held to be the principal species, the increase of which is one of the objects in view. The shortleaf at present fetches a slightly higher price, since it carries less sapwood, but the loblolly is faster growing, easier to regenerate, forms a denser and purer mass and consequently is a more profitable forest.

Part II discusses the question of yield, the effect of fire protection (which cannot be undertaken all at once), the interest returns, and the rules for management. The method adopted is selection, and the possibility is limited by a diameter of 12 inches at breast height. This is very small, but the forest has to provide steady employment for sawmills able to turn out 40,000,000 board feet per annum. If these mills are to be kept in full work, another 170,000 acres will have to be obtained, for with the 12 inches limit the yield will only be about 15,000,000 board feet. Whether the limit be placed at 12 inches or up to 20 inches

the crop will be ready for another selection in about 42 years, and the interest on capital varies between $3\frac{1}{2}$ and 9 per cent., according to the size, the prices assumed, and the stumpage value assigned to the cleared land. The refuse is to be burnt in order to give fires less chance of running through.

Bulletin No. 33 is about the Western hemlock (*Tsuga, heterophylla*) by E. T. Allen. This is a tree whose reputation has suffered by confusion with its Eastern namesake. It is found from Alaska, through Oregon, Montana, Washington, etc., to California. It is a large tree up to 8 feet diameter and 250 feet high, and though rejected by lumbermen, is quite fit to replace the various firs, spruces, etc., that are now becoming scarce. It is indeed surreptitiously substituted for these by some few who have realised that the timber is good enough if its real name can be concealed. The *Bulletin* contains 23 excellent half-tones of the tree in its native haunts, its wood, and its diseases. One of its great advantages is that white-ants do not touch it. Comparative tests were made with this object, and one reads with an inward chuckle that in the case of California redwood and Califorina white cedar that the "ants tried, but discontinued after slight effort." It is said that Western hemlock is so distasteful to rodents that they will not attack corn-bins made of it. Casually it may be mentioned here that a solution of quinine is a cheap and effective caution to rats that are given to gnawing boxes, etc. They take one little chunk out, drop it at once, and make tracks.

The bark is a valuable tanning material, and the tree has two distinct kinds of bark in different localities. Above 2000 feet it is rough and often two inches thick, while at lower elevations it is much thinner and smoother. A "peeling crew" consists of three men. The "faller" is a feller. The "fitter" trims off branches, rings the bark at intervals of four feet, and slits each section lengthways. The "spudder" peels the bark with a flattened bar, and spreads it on the ground, with the inner side, or flesh, up. After curing in the sun for five or ten days it is carefully piled, outside up, to season, which takes two or three months in dry weather. If left till winter it becomes covered with snow or ice, curls badly, and loses much of its value. The tanning is 10 per cent for Eastern and 16 per cent for Western hemlock bark, with of course variations. The "long cord" of the East is 2240 lbs. In the West there is also a "short cord" of 2000 lbs. Stems are peeled up to 12 inches diameter. It takes 45 trees 13 inches thick, 11 trees 20 inches thick, three trees 30 inches thick, and one tree 50 inches thick to furnish the long cord. An acre of pure young second-growth hemlock may yield at 50 years two cords, at 80 years nine cords, and at 120 years 11 cords.

Bulletin No. 34 is a very interesting one on the "History of the Lumber Industry in the State of New York," by W. F. Fox,

with 30 more of the excellent half-tone pictures. The earliest settler was the first lumberman, but it is stated that the destruction of the forests is due to the farmers and their fires, rather than to the lumbermen, who do not intentionally burn forests.

In 1614, when the first houses were built, the State of New York was forest throughout, with the exception of a few crops of the indigenous Six Nations, and a few small areas burnt by them for hunting. The principal species was white pine, a species averaging two to four feet diameter and 130 to 160 feet high, but known to reach 255 feet high and seven feet diameter. Other species are the shortleaf (*Pinus echinata*) or Yellow Pine, the Norway pine, hemlock, spruce, balsam, white cedar, etc. In the town of Colchester there is a hemlock which was marked when it was six inches thick, in 1535, probably by an Indian weapon. Two hundred and fifty-three annual rings later, it was blazed by James Cockburn in 1788, and again in 1816 by Christopher Tappen. Sawmills were established over a century before any existed in England. In the old country the early sawmills were destroyed by mobs objecting to labour-saving machinery. In 1623, nine years after the first house was built at New Amsterdam, three sawmills were erected there by the Dutch West India Company, who thus became the pioneers of lumbering as an industry. About the same time, perhaps a little earlier, some sawmills were erected at Fort Orange (Albany) and Andries Corstiaensen ran them. Thenceforward mills and water-wheels multiplied rapidly. In a letter to the Lords of Trade, England, dated January 2nd, 1701, the Earl of Bellomont says "they have got about 40 sawmills up in this Province (New York) which I hear rids more woods and destroys more timber than all the sawmills in New Hampshire." There is a picture of one of these old mills, with a single upright saw attached directly to the pitman, and kept steady by side pressure from guide blocks. Later the saw frame was invented for keeping the saw under tension. Even at the time of the Revolution there was a lumber trade with England, but even after that event four-fifths of the State was an unbroken wilderness.

In 1626 the *Arms of Amsterdam* carried a consignment of oak and hickory to Holland, and in 1675 *The Castle* carried £400 worth of lumber to England. In 1686 Governor Dongan reported that he could "send over boards of what dimensions you please," adding that "three-inch planks for the batteries cost me 15 shillings the hundred feet." There was no river-driving then. When the lead became too long, the lumbermen simply up sticks and moved the mill. There were timber thieves even in the old days of plenty. Mr. Nathan Ford in 1799 complains that several persons were pretending to settle while really stealing the timber, but Mr. Wilkins took down their

names. They do not seem to have cared much for either Mr. Ford or Mr. Wilkins. "If something is not done about this business, great destruction will arise. An example ought to be made, and this cannot be done without sending an officer from Fort Stanwix. They have got the timber so boldly that they say there is no law that can be executed upon them here." But in 1770 Adolphus Benzel, son of Archbishop Eric Benzel, of Sweden, was appointed Inspector of His Majesty's Woods and Forests at £300 per annum.

As early as 1700, Lord Bellomont recommended that each person who removed a tree should pay for planting four or five young trees, that no tree should be cut that is marked for the use of the navy, and that no trees be cut but when the sap is in the root.

The life was dangerous then as now. The first deaths in a settlement were frequently those of men killed by falling trees, crushed under loads, killed in sawmills, cut off by fires, or drowned while floating logs. "In May 1817 Artemas Shattuck went into the woods to chop. While cutting off a log that had been partly split, his foot caught in the crack, and he hung for a long time suspended by his foot and partly supported by one hand." Despairing of receiving aid, he finally unjointed his ankle with his pocket knife, made a crutch of a crooked stick, and started for the house." Rafting only began about 1788. The rafts in 1865 (when the author of the Bulletin, Mr. Fox, was engaged in the trade) consisted of sections 16 feet square called "platforms." Five of these platforms side by side, with three more 5 platform pieces following, formed a raft 48 feet wide and 160 feet long and might contain 180,000 feet of lumber, board measure. The rafts would run 40 or 50 miles a day on ordinary floods and were tied up at night, generally near some town, village or tavern for company and amusement. Then if there were no genuine disputes to settle, there was always the question as to who was the best man to be decided.

In 1872 it appears from the books of the Hudson River Boom Association that 1,069,000 standards, or 213,800,000 feet B. M. were handled. This was the highest point of the trade, and at that time lumbermen were not cutting below 12 inches diameter on the stump, or nothing less than "two-log" trees. The "standard" log is 19 inches diameter at the small end and 13 feet long. Hence the logs then delivered ran about two to the standard, say 2,000,000 logs. In 1890 the business had declined to about a quarter.

"Log-driving," a most perilous business, began about 1800, and required men of superb physique and agility. It is now nearly extinct. "With surprising agility they would leap from log to log while they were running down the rapid swirling

current, and standing upright on a small log, with nothing to aid them but a pike-pole or lever, they would guide their treacherous craft as skilfully as an Indian his canoe. Many a good man met his death in the cold white foaming rapids."

"Log-rules" are contents tables for the sale of logs, and in the State two rules exist. Prior to 1850, E. Doyle published one set and J. M. Scribner another. Being practical rather than mathematical, these rules differ materially, on account of the different allowance made for kerf, slabs, waste, defects, etc. The Doyle rule is based on an arbitrary formula which is fairly correct for medium sized logs, but not for others. Starting with the usual 16-foot lengths he arrives at the number of feet board measure in a log of that length and of any diameter by deducting four inches from the diameter and then taking tne square of the difference. For instance, for a log 16 feet long and 20 inches diameter the formula is $(20'' - 4'')^2 = 256$ feet. A log 12 feet long and 20 inches diameter would be said to contain $\frac{12}{16}$ of 256 feet and so on. Scribner went to work by plotting circular diagrams showing the number of square-edged boards in a log properly sawn. From these diagrams the amount of lumber was computed for each diameter, after which a fixed percentage was deducted for imperfections. Both rules agree fairly for logs of 24 inches diameter, but for small logs Doyle's figures are much below Scribner's, while for large logs the contrary is the case. As the majority of logs are small, and the sawmills, as purchasers, naturally insist on Doyle's rule, Scribner's is now rarely used, and as a matter of fact, with the usual more or less inferior class of timber, Doyle's is the more practically correct. The "standard" is a log 13 feet long and 19 inches diameter at the small end. The method of comparison for logs of the same length (13 feet) is to divide the square of the diameter of the log at the small end by the square of the diameter of the standard, that is 361. The result, whether decimal or whole number, expresses the size of the log in terms of the "standard" as unit. Five standards are considered equivalent to 1000 feet board measure. The "standard," according to Doyle, contains 183 feet B. M., and according to Scribner, 195 feet. But it is proved by repeated tests that a sound straight standard log carefully sawn will yield 200 feet of straight edged boards, and this is the assumption of the Adirondack lumbermen, who make five standards equal to 1000 feet. The term "market," meaning marketable logs, is often used instead of the term "standard," although it may take 60,000 saleable logs to make up 20,000 "markets." The older modern mills driven by water-power generally use gang-saws, as many as 30 in a frame. The more recent mills driven by steam add a large circular saw and now-a-days band saws.

In a lumber camp the best axe-men fell the large trees. Some of these men are so expert they will set up a stake as a

mark, and fell the tree so exactly that in falling it drives the stake into the ground. This avoids much breakage of younger trees. Those who trim off branches are called "guttermen," those driving the teams "skidders." The logs are rolled into huge tiers on the skidways ready to be loaded on sledges when the snow comes. Here the "scaler" and his assistant measure each log inside the bark at both ends, enter it in a book, and stamp both ends with the owner's mark. The contractor who runs the camp and work is called a "jobber," and the laying out of roads is one of the most important things he has to attend to. A "champion" sledge load may contain as much as 5000 or 6000 feet.

Then comes the river driving. "At times, in some crooked rocky stream, a jam as formed, and thousands of logs are wedged fast in the channel, held back by some one log firmly braced against an impediment. Then occurs a thrilling scene, as the foreman calls for volunteers to break the jam. There is always a prompt response. Two or more daring fellows, impelled by pride in their work, take their lives in their hands, and, with an axe and handspikes make their way over the treacherous logs to the head of the jam. Behind them are thousands of logs filling the angry stream from bank to bank, piled thickly to the bottom in all shapes, tossing, tumbling, and leaping in the air as the dammed up torrent forces them about in wild confusion. Beneath the men is the swaying, rocking, unstable mass, somewhere in the midst of which is the log which forms the key to the position. The balance of the crew of drivers gather on the bank below, where they watch with intense anxiety the men who have volunteered to break the jam. They note every motion of the volunteers as they coolly and undauntedly proceed with their work. The critical moment is close at hand. There is a little more prying with the handspikes, a few more blows with the axe, and then suddenly the huge threatening mass begins to move. Above the sound of the foaming waters a warning shout goes up from the men standing on the bank, and then, leaping from log to log, as the jam breaks, the brave fellows reach the shore in safety amid the applauding cheers of their comrades; or, it may be a cry of horror breaks from the crew, one loses his foothold and disappears beneath the terrible grinding mass, crushed and torn to a mere semblance of humanity."

In felling, the saw is now being largely used instead of the axe, and all trees are cut close to the ground. There are water slides miles in length, and logs are handled by steam jacks and loaders, and planing machines are being added to the equipment of sawmills.

Wood pulp has produced a great and prejudicial change in the conditions of lumbering. About 1867, the first mills were erected for grinding wood to pulp against a grindstone, and for disintegrating

the timber by chemicals. There are now 293 mills in the States, of which 1 2 are in New York State. At first poplar was used, and foresters were pleased, for poplar is an otherwise useless weed. But soon spruce also was attacked, and pulp unfortunately prefers fine young pole. The result is that, whereas the old lumbermen took out only the finest trees and did great damage, now the new ones take everything, and leave black ruin. To save transport, trees are peeled in the forest, and this is called "rossing." The bark so left causes great danger from fire. In 1898 the total cut in Adirondacks amounted to 544,234,207 feet, of which 529,281,918 feet went into pulp. The lumber industry of New York attained its maximum before 1865. In 1880 the New York mills turned out 1,148,220,000 feet B. M., not including laths, shingles and staves. The Adirondacks and Catskill ranges are now almost exhausted, and the production is only about 250 millions of feet of sawn stuff and 200 million feet of pulp. Another authority places the total output of New York State at about 900 millions from all sources. Working Plans are now coming in to save what is left of the situation, but the man who in 1799 advertised the half share in a sawmill has long since passed away, and so has his "inexhaustible quantity of pine wood." Let us look to the beam in our own eye. An Administration that thinks all cultivable land ought to be cultivated can certainly not be said to possess the best vision possible.

F. GLEADOW.

Grass for Paper Manufacture.

MR. GAMBLE in a list of trees and shrubs in the Ganjam and Vizagapatam districts, written some years ago, mentions a species of grass which he calls *Andropogon involutus* and which he mentions as being equal to the "Esparto" grass as a material for paper manufacture. I have lately identified a grass in the Vizagapatam district with the bhabar grass of the Central and United Provinces. It bears the characteristic woolly base of the *Ischœmum angustifolium*, and is locally put to the same uses as the bhabar grass is by the natives of the United Provinces, *viz.*, twisted into twine and rope for charpoys. One more use it is put to on the sea coast is the seaming of fishing boats and the making of the large fishing nets used in the sea. What I should like to know is if *Andropogon involutus* is synonymous with *Ischœmum angustifolium* or is it a separate species of grass altogether?

The local name of the grass I refer to is "Kopiri," or more correctly "Kamkku kopiri," because there is another called also "Kopiri" and more correctly "Nunna kopiri," which is probably *Eriophorum comosum*; and in a recent working-plan for a forest in the Godavery district, the W. P. O. referred to "Kopiri" grass there—which is evidently identical with the "Kopiri" of this (Vizagapatam) district—as *Andropogon involutus*. I therefore feel rather doubtful about the identity of my grass and should like to have my doubts cleared.

The Central Provinces seems to make a large revenue by its "Bhabar" grass. There is a possibility of the Northern Circars districts of the Madras Presidency possessing great potentialities of revenue in regard to their "Kopiri" grass. I request therefore that some of my brother officers in the Central Provinces will kindly give information in the *Indian Forester* that will help their brethren in this Presidency in their endeavours to work up the "Kopiri" grass for the Calcutta paper-mills. Information is solicited on the following points:—

(1) Method and time of year of collection.

(2) Cost of collection per maund (82 lbs.).

(3) Method and means of transport and cost per maund, by road and rail separately, for a given distance.

(4) How is the grass packed and transported? Is it compressed to reduce bulk?

This and any further information which may appear helpful and necessary shall be most thankfully received. And as its publication in the *Indian Forester* is likely to benefit many more than myself, I request you will kindly undertake to publish the same in the *Indian Forester*. One more point I should like to

VII.—TIMBER AND PRODUCE TRADE.

Churchill and Sim's Circular.

December 3rd, 1902.

East Indian Teak.—The deliveries have improved during November, amounting to 1279 loads, against 1051 loads for November 1901. For the eleven months the comparison shows 11,760 loads this year against 13,047 loads last. Prices are also a point better than in October both for logs and planks, and

business generally more active, consumers recognising that there is no sign at present of relief from high prices and tiring of their recent waiting policy. The improved supply of water in the shipping rivers seems to be maintained, but the process of getting down and shipping supplies of fresh timber appears to be lengthy.

ROSEWOOD, EAST INDIA.—Stocks are quite sufficient to meet the current demand, which is small.

SATINWOOD, EAST INDIA.—Finely figured logs sell well, but plain wood is very quiet; stocks are, however, very moderate.

EBONY, EAST INDIA.—Sizeable, good logs would realise fair prices.

PRICE CURRENT.

Indian Teak, logs, per load ...	£10 10s to £18 10s.
" " planks " ...	£13 10s. to £20.
Rosewood, per ton	£7 to £10
Satinwood, per s.ft.	5*d.* to 12*d.*
Ebony, per ton	£9 to £10

THE
INDIAN FORESTER.

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Forest Fires.*

DAMAGE THROUGH LOSS OF THE SOIL-COVERING.

So far as I remember, the only occasion on which the daily press has done the *Indian Forester* the honour of quoting anything was in the case of an article of a somewhat pernicious nature in which the author advocated forest fires. He did not specify the precise localities, conditions, and limitations under which a forest fire may be supposed to be more or less beneficial. The article was only *quoted* as bearing on the breeding of mosquitos, but the Revenue Officer and the public may *seize on it* as a warrant for disputing the need of anything so oppressive as *fire protection in general*. Hence I call it somewhat pernicious. The following translation of an article by M. Jacquot in the *Revue des Eaux et Forêts* for 1st June 1902 may be of use towards a study of the question. In any case it is worth preserving. This and the final paragraphs alone are mine.

DEAD LEAVES.

M. Berthelot, and more fully MM. Gauthier and Drouin, have proved that a fire, if sufficiently intense to decompose the humus and humic acid, thereby destroys the faculty they possessed of developing those most essential and scarce substances which contain nitrogen. Even if the fire does not destroy woody tissues it burns up the covering of dead leaves. M. Détrie suspected what M. Coudon and especially M. E. Grandeau have proved, *viz.*, that these dead leaves possess the precious faculty of *absorbing nitrogen from the air*. Since MM. Schlœsing and Müntz in 1877 discovered the nitromonad, the first bacterium whose powerful action on the chemical changes in the soil was

* Brief translation of an article by M. Jacquot in the *Revue des Eaux et Forêts* for 1st June 1902, with remarks by F. Gleadow.

proved, attention has been concentrated rather on its agricultural than on its forest utility. The researches of M. Henry therefore mark an important step in science. By his experiments in 1897 the learned professor of the Ecole Forestiere proved that dead leaves may even double their original richness.

The quantity of leaves produced annually on 1 hectare (2½ acres) varies with the soil, climate, species, age, treatment, and density of the crop and the luxuriance of the crowns. It may reach 12,000 kilogrammes (of 2¼lbs.) of the living substance. The Bavarian stations have supplied some valuable figures, but these, as M. Henry remarks, are minima. "They relate indeed to forests afflicted with rights to fodder. The impoverishment resulting from this detestable practice reacts fatally on the vegetation." Other countries supply similar proofs. Jaeger and Buro, working under the same conditions, arrived at the same results as Professor Ebermayer. But Dr. Krutsch, examining soils that were not so impoverished, found weights one-fourth greater for spruce and one-seventh greater for Scotch pine. The latter would have given figures as good as the spruce if the crop had been thinned so as to bring it under better conditions of light and air. "On trees which are prospering in sufficient light and liberty the leaves are not only more numerous but larger than on trees growing on poor soil or in bad condition." M. Hüffel's work "Les Arbres et les Peuplements Forestiers" gives an account of the density of the German pine forests and shows the enormous increase of production which is obtained when these forests are treated by early and frequent thinnings. In Bavaria itself, under good cultural conditions, the dead covering has given figures considerably superior to those obtained when sweepings took place at six years' intervals (weight of all organic débris fallen during six years and not yet decomposed).

AVERAGE WEIGHT OF THE COVERING.

Forests.	Gathered off soil subject to sweepings.		Gathered off soil not thus impoverished.
	Annual.	Sexennial	
	Kilos.	*Kilos.*	*Kilos.*
Beech ...	4107	8460	10,417
Spruce ...	3538	9390	13,857
Scotch pine ...	3706	13 729	18,279

The researches of M Henry in the high forests and stored copices of France confirm the above. Thus, in Lorraine, though

it is one of the coldest and foggiest provinces, a full-grown beech forest furnished in one year twice the weight gathered in Bavaria, that is to say, over 5000 kilograms of leaves dried at 100°C. and over 8000 kilos of total dead covering. A table can thus be prepared on the model of those used by the Director of the Bavarian stations. Experiments have not been made with all species at all altitudes and in all climates. Hence a mean has to be struck which is liable to slight variations in special cases. But a dictum of M. Ebermayer limits the probable error. "The differences in the quantity of leaves produced by the several species at the same age cannot be very great." The figures have been derived from crops growing under ordinary conditions. Consequently they are greater than those obtained from crops impoverished by sweepings, and less than the maxima for either France or Germany. They vary but little from truth, and experts are free to adapt or modify them for special cases.

WEIGHT OF THE DEAD COVERING, FULLY AIR-DRIED, PRODUCED ANNUALLY PER HECTARE OF HIGH FOREST.

Crop.	Leaves.	Debris excluding phanerogamic living axile organs	Total.	REMARKS.
	Quintaux.	Quintaux.	Quintaux.	
Beech aged 10 years ...	19	12	31	If regeneration has not been satisfactory, the figures must be reduced.
" " 20 " ...	30	13	43	
" " 30 " ...	39	20	59	
" " 40 to 60 years	47	29	76	
" " 60 to 90 "	46	28	74	
" " over 90 "	45	28	73	Weight diminishes with age.
Oak " 10 years ...	14	10	24	For oak the figures are approximations. Experiments insufficient.
" " 20 " ...	23	11	34	
" " 30 " ...	29	18	47	
" " 40 to 60 years	37	25	62	
" " 60 to 90 "	36	24	60	
" " over 90 "	35	25	60	
Hornbeam 10 years ...	9	12	31	
" " 20 " ...	30	13	43	
" " 30 " ...	37	20	57	
" " 40 to 60 years	42	27	69	For hornbeam do. do.
" " 60 to 90 "	40	26	66	
" " over 90 "	36	28	64	
Scotch pine 25 to 50 "	34	22	56	Weight increases with age.
" " 50 to 75 "	35	23	58	
" " 75 to 100 "	40	30	70	

The metric *quintal* is very near 2 cwt.

In the stored coppices studied by M. Henry "the weight of the dead covering rises steadily to the age of 10 years, from which period to the felling it oscillates round 5500 kilos of dry substance for forests and soils such as those of the Forêt de Haye." In this quantity of total débris the share of the leaves varies from one-third to three-fourths. The following table gives the weights found at ages of 1, 20 and 30 years; those for 6 and 10 years are interpolated from the known inclusive totals of leaves and twigs, etc., combined.

WEIGHT OF THE DEAD COVERING PRODUCED ANNUALLY PER HECTARE BY A STORED COPPICE OF OAK, BEECH, AND HORNBEAM.

Age.	Dry soil (Oolite).			Clay soil.		
	Leaves.	Debris excluding living phanerogams.	Total.	Leaves.	Debris.	Total.
	Kilos.	Kilos.	Kilos.	Kilos.	Kilos.	Kilos.
1	600	1500	2100	...	...	...
6	2000	2400	4400	...	...	...
10	3400	2300	5700	...	...	...
20	3900	1300	5200	2800	1800	4600
30	3100	2400	5500	...	...	...

M. Henry augments the force of his demonstration by assuming the least favourable case, and neglecting the soluble compounds of ammonia, starches and nitrates, which may have been formed and washed out by rain. According to his weighings, at the end of one year a weight of 100 kilos of oak and hornbeam leaves produces a gain of at least ·666 kilo of nitrogen. The leaves have by that time lost their colour, but not their form, and are far from being reduced to humus. Their action as gas-absorbers is slowed down, but only ends with their complete decomposition. This takes three years for certain common species such as beech, and nearly twice as long for pine needles. It is thus a very moderate estimate to say that, after allowing for all losses of gas returned to the atmosphere during the process of decomposition, there still remains ·850 kilo of nitrogen absorbed and fixed from the air by each 100 kilos of dead leaves. This quantity is pure profit, the increment of the leaves from the moment they fall to the ground. But at the time of falling they

contain a certain quantity. The analyses of MM. Fliche, Grandeau and Henry, which are wider than those of Wolff, give the following figures:—

Species.	Albuminoids in dead leaves (November).	Corresponding weight of nitrogen per 100 kilos of dead leaves.
	per cent.	Kilos.
Beech	7·81	1·250
Oak	6·62	1·060
Scotch Pine	11·81	1·890
Birch	3·00	0·480
Chesnut	3·75	0·600
Larch	5·50	0·880
Spruce	8·43	1·350

The percentage of nitrogen is over 1 per cent. for the principal species. It may be considered as the minimum for oak, beech and hornbeam. The total loss of nitrogen resulting from the burning of the leaves is therefore 1·850 kilos per 100 kilos of dry leaves of these three species. Probably it is at least 2·500 kilos for pine, but for safety it may be taken as 2 kilos.

Debris.

The dead twigs, etc., etc., which reach the ground are also nitrogenous compounds. "They decompose more or less slowly, but always end by conversion into substances useful to plants (such as starches, nitrates, ammoniacal salts). A fire, even a slight one, destroys these small organs and dissipates the nitrogen, which exceeds ·7 per cent.

Under normal conditions the nitrogen derived from the two above-mentioned sources would have contributed to the formation of ulmic compounds and humus incorporated in the vegetable soil. A fire dissipates it in pure loss. The damage corresponds to the price of a *manure containing the same proportion of the gas.* This will vary, according to localities and manures available, from 1fr. 50c. to 1fr. 85c. (15 to 18¼ pence) per kilogram for mineral manures; farmyard manure would cost 2fr. 50c. per kilo of nitrogen contained. Tables could thus be drawn up, according to the nature and price of various manures, showing the money value of the dead covering exclusive of ashes. On a clay soil for instance nitrate of soda may work wonders, as seen in the nurseries

of MM. Huberty and Guffroy. If the nitrogen contents is 15 per cent. and the price 24fr. 75c. per quintal, the kilo of nitrogen works out to 1fr. 65c In the case of a hectare of high beech, aged 100 years, the loss of the soil covering would amount to 169fr. 70c. (over £2 16s. or Rs. 42 per acre), since the 4500 kilos of leaves and the 2800 kilos of débris represent respectively 83·250 kilos and 19·600 kilos of nitrogen. Similarly, in the case of a 40-year old pine forest the loss will be 137fr. 60c.; and in the case of a 6-year old stored coppice, the loss will be 88fr 75c. per hectare. The cost of transport and labour would be additional.

The artificial product applied to restore the loss contains, it is true, some other substances of a fertilising nature, but these cannot be considered as replacing any of the nitrogen due. Mineral foods cannot be substituted even for each other. Forest crops, though less exhausting than field crops, nevertheless make equally imperious demands for certain substances and suffer equally severely as soon as any one of the necessary elements becomes insufficient. Field manures are intended for field crops, and do not produce the same effects in forests. What the latter want is nitrogen, and nothing else can make good the loss of the soil covering. The author of a forest fire should be compelled to make good the loss under strict analytical tests to within 1 per cent., and he should furnish that manure which is most appropriate to the soil and the season; nitrate of soda for clays and compact soils, since it soon disappears in permeable ones; sulphate of ammonia (20 per cent. nitrogen) for calcareous or less compact soils; organic manures, such as dung (4 per cent. nitrogen), dried blood (11 per cent.), oil-cake (4 to 5 per cent.), ground horns, hair (14 to 15 per cent.), etc., for light and strong soils. In spring and summer when roots are active, a quicker manure may be used. In winter one of more durable nature.

M. Jacquot proceeds to consider the time of year at which the fire takes place, and the effect of a second fire following the first at one or two years' interval. The former question is entirely negligeable. The second he does not develop fully, and *in fact if the fire recurs before the next set of leaves are* decomposed, the matter becomes complicated. The idea of a forest incendiary having to make good the damage, in addition to his punishment, will be a startling novelty in India. Nevertheless it is unassailable, and even admissible under the Forest Act.

F. GLEADOW.

The Insect World in an Indian Forest and how to study it.

BY E. P. STEBBING, F.L.S., F.E.S.

(*Continued from p. 68.*)

PART V—(*continued*).

ORDER.—*COLEOPTERA*—(*continued*).

HETEROMERA.

THE first and second pair of legs have five-jointed tarsi, the third pair having four only.

FAMILY TENEBRIONIDÆ.

Very common beetles in India. Owing to their dark colouring and shape they have a general resemblance to the *Carabidæ*, from which they can of course be distinguished by the tarsal joints. The larvæ are elongate and cylindrical and are hard and have six legs, being not unlike Elaterid grubs. Their food is mostly vegetable matter, including grain and flour. Some years ago a species was reported as tunnelling into sandalwood in Mysore, but the specimens were in bad condition and could not be identified. Recently the writer was able to breed an as yet undetermined species of Tenebrionid beetle from larvæ taken from the wood of dead spruce and blue pine trees in the Jaunsar Division in the N.-W. Himalayas; the timber tunnelled into was in several cases still sound, though in others rotting.

FAMILY CANTHARIDÆ (BLISTER BEETLES, OIL BEETLES).

Head with an abrupt neck; no hind wings present, elytra short and do not fit well together, but overlap; each claw of the feet has a long appendage beneath it. The beetles have a very soft integument and they secrete irritating secretions which raise blisters on the skin. Some of the insects are wingless. The *Cantharidæ* feed upon flowers and leaves and frequently do a little damage in this way. A common one in India, *Mylabris*, has the elytra banded with yellow and black stripes. Several others are equally typically marked.

TETRAMERA.

Four tarsal joints are present on all feet. Several of the families of this group contain serious pests both to forests and agriculture.

PHYTOPHAGA.

The head does not form a definite prolonged beak or rostrum; the three basal joints of the tarsus are densely covered with pubescence beneath, the third joint being divided into two lobes so as to allow of the fourth joint being inserted near its base.

FAMILY BRUCHIDÆ.

These are small unattractive beetles, having the hind femora more or less thickened. The front of the head is produced into a

short rostrum and the antennæ are bead-like and straight, thus distinguishing them from the *Curculionidæ* where the antennæ are elbowed. The larvæ are little white, fat maggots, without legs, and live in and feed upon the seeds of plants, more especially the *Leguminosæ*. In India leguminous plants of all kinds are attacked by members of this family, and it is probable that the seed of leguminous forest trees suffers heavily from these pests. A species of *Caryoborus*, *C. gonagra** attacks the seeds of the tamarind (*Tamarindus indica*), its life-history being as follows :— The eggs are probably laid on the pods before they reach maturity. The larvæ on hatching out make their way through the pod and tunnel directly into the seed. It has been found that none of the seeds contain more than one grub. When full fed the grub leaves the seed and spins a close-matted cocoon inside the pod and passes the pupal stage within this. The beetle, which is brown in colour and about the size of a pea, after emerging from the pupal skin, rests for sometime before cutting its way out of the cocoon and pod. Since there is only one set of pods per year, the life cycle probably takes a year to pass through.

FAMILY CHRYSOMELIDÆ (LEAF BEETLES).

Antennæ moderately long, eyes round and do not at all surround the insertion of the antennæ. The insects are small, bright-coloured, and thick set. The head is usually partially sunk into the prothorax, and the insects differ in appearance from other tetramerous beetles. Both the adults and larvæ feed upon leaves, and several do much damage in India by defoliating crop plants. A species, *Melasoma* sp., has been reported as defoliating a willow in the N.-W. Himalayas†; whilst a member of the group *Halticides* was found by Mr. Wroughton and the writer feeding upon the leaves of *Boswellia serrata* near Poona†; at present, however, but little is known as to their action in the Indian Forest. The larvæ are small and active and are sometimes covered with spines, on which they carry their cast-off skins as a kind of shelter. The pupæ may be found either on the leaves or in the ground, and several generations may be gone through in the year—a fact which intensifies the insects' capabilities of inflicting damage.

FAMILY CERAMBYCIDÆ (LONGICORN BEETLES).

A large family of beetles containing from 12,000 to 13,000 known species. In form they are usually long, with well-marked "shoulders" to the elytra and a vertical head. The antennæ are very long, consisting of long cylindrical joints, often tumid at the nodes. They are held over the back in the position of rest. The eyes are hollowed out round the insertion of the antennæ. The latter are longer in the male than in the female. The first three joints of the tarsus are always large, spongy, bi-lobed and covered

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* *Vide* Injurious Insects of Indian Forests, pp. 49-50. † *Id.*, p. 50.

† *Vide* Departmental Notes on Insects that affect Forestry, No. 2, p. 179.

with hairs. The beetles are of all sorts of colours (but rarely metallic as in the case of the *Buprestidæ*), being often covered with hair or having hair in tufts on them. The thorax is square in outline and cylindrical and in most cases spined. The ♀ has a long strong ovipositor for laying eggs in crevices. The legs are long and strong. The larvæ are almost entirely wood-feeders and so are white and soft. They have a broad head, powerful jaws, and long body, but have not the enormously developed prothorax of the buprestid larva which they otherwise greatly resemble; in the longicorn larva the abdominal segments are nearly as broad as the prothorax, it is practically legless, and has four-jointed antennæ. The grubs often spend their lives burrowing up and down in the wood of trees, making galleries which have usually a larger diameter than those of buprestids, and when they change into the pupal state, they do so either in the outer layer of the wood or in the bark, and the beetle is thus enabled to bore its way out.

Three sub-families of this family are distinguished as follows:—

Prionides—The front coxæ large and transverse; prothorax has distinct side margins.

Cerambycides—Front coxæ not greatly extended transversely, thorax not margined; the head is sloped in front obliquely, palpi have the terminal joint truncate, the inner side of the tibia has no groove; small legs are just visible in the larva.

Lamiides—Front coxæ usually round and deeply embedded; head is vertical and the terminal joint of the palpus is pointed and the inner side of the tibia has a groove; legs invisible in the larva.

The *Prionides* are on the average considerably larger in size than the members of the other divisions, and they include some of the largest of insects. Some have a great development of the mandibles in the male sex, analogous to those of the stag-beetle of the *Lucanidæ*. The larvæ in various parts of the world appear to have been a favourite article of food with native tribes. In consequence of the great destruction of forests that has taken place so largely in many countries of late years, these gigantic cerambycids have become much rarer.

The modes of life of the larvæ of the sub-families *Cerambycides* and *Lamiides* are various. Some bore up or down in the hard wood of trees and live for a portion of a year or for several years in this condition before changing to the beetle state. The female beetle in others girdles twigs of trees and then lays her eggs in the branch above the girdle. An example of one of these insects is the sal girdler, *Coelosterma scabrata*, whose life-history is as follows:—The female lays her eggs towards the end of the rains in notches in the bark of the shoot, somewhere near the upper

end, either of a leading shoot or side branch. The beetle then girdles the shoot below the point she has laid her eggs in. The shoot dies above the girdle and the larvæ on hatching out feed upon the dying wood thus provided by the female. They change to the pupal state within this dead portion, which will probably by then have been blown or got knocked off the tree. The beetle emerges during the rains, laying its eggs towards the end of this season.

A common cerambyx wood-borer in India is *Plocederus obesus*. The eggs of this beetle are laid in crevices in the bark of the tree about March or April and the young larvæ on emerging first feed upon the bark and cambium layer and outer sapwood. As it becomes stronger it goes right down into the heartwood of the tree, boring large galleries in it. When pupating the larva forms a peculiar solid calcareous cocoon in the outer layers of the wood. The insect pupates in August and September, becoming a perfect beetle in November. The beetle remains in the cocoon until March or April of the succeeding year to enable its outer parts to slowly harden, and then cuts its way out of this and of the wood. Recent observations tend to show that the larva only lives about six months in this stage of its existence in the Siwalik forests, where it is very common in *Odina wodier* and other trees. *

Another beetle, *Hoplocerambyx spinicornis* (the Singbhum sal borer) lays its eggs in the sal. The larvæ when full-fed, instead of forming the calcareous cocoon of *Plocederus*, cover over the outer portion of the tunnel with a white calcareous covering resembling the end of a Brazil nut. This insect is common in the sal forests of Chota Nagpur, its larvæ probably spending more than one year in the tree, where they bore right down to the heartwood. †

A similar or closely allied species attacks the sal in the Siwaliks, and its galleries are to be found in consi erable numbers in the sal posts (tors). As far as present observations go the genus would appear to contain the most aggressive of the sal wood borers.

RHYNCHOPHORA.

The head forms a more or less elongated beak or snout. The third tarsal joint at least is usually broad and densely pubescent beneath.

FAMILY CURCULIONIDÆ (WEEVILS).

The head is prolonged into a well-marked beak called the 'rostrum,' which bears a pair of elbowed clavate antennæ on it and carries the mouth parts at its tip. The palpi are small and the labium absent. The elytra bend down over the edge of the abdomen.

* In the 2nd edition of Gamble's *Manual of Indian Timbers* this insect is alluded to as probably the chief insect enemy of the sal tree. Present observations, however, by no means shows this to be the case.

† Vide *Injurious Insects*, p. 71, Plates IV, IX, c. (larva).

The *Curculionidæ* are an enormous family of beetles, containing about 25,000 known species, which do damage to the wood, leaves, shoots, fruits, and seeds of trees and crops. They have been reported in this connection from many parts of India. The larvæ are white legless grubs, which tunnel into vegetable matter of all kinds. The Palm weevil (*Rhynchophorus ferrugineus*,*) is a typical example of this family. The female lays its eggs at the base of the leaf stalks on some spot where the stems have been injured, or in the holes drilled by the rhinoceros beetle (*Oryctes rhinoceros*). The larvæ tunnel their way through the heart of the trunk and often kill the tree outright. The pupa is formed in a cocoon of palm fibre in the burrow. The beetles fly at night, being often found in the day in the holes of the rhinoceros beetle. The palms in the Saharanpur Botanical Gardens were badly attacked in this way some years ago, several being entirely killed, whilst others were so riddled that they had to be cut down. This beetle is a common and serious pest in parts of Madras and other places in India.

Remedy.—There can be no doubt that in valuable plantations the best treatment is to at once cut out and burn entirely all infected trees. Of course to secure permanent good this must be done throughout the whole of the plantations of a district or series of districts and not only in one or two, as these latter will soon become reinfected from the neighbouring untended areas.

Mahogany, *Pinus khasya*, and dhak have been reported as tunnelled into by weevils. In the case of the former two, the grubs feed in the bast, gnawing out large winding galleries in it. When full-fed they eat out a chamber in the sapwood and pupate in it.

The shoots of the hill bamboo (*Dendrocalamus*) are bored into by the weevil *Cyrtotrachelus dux* and tops so attacked die off.

In the Chittagong Hill Tracts a large weevil named *Cyrtotrachelus longipes* attacks young muli bamboos (*Melocanna bambusoides*) when they are 1—2 feet above the ground. The female, a large brown beetle with a long rostrum, fairly long elbowed antennæ and enormously developed front legs, lays two eggs on the side of the shoot towards the end of June. Only one of these eggs appears to develop as only one larva is subsequently found in the shoot. On hatching out the young larva tunnels directly into the heart of the shoot and then burrows down the centre of it till it reaches the ground level. It then moves back to near the top and cuts the shoot through all round below it; the top containing the grub thus falls to the ground and gets pressed or dragged into the rain-sodden soil. The larva then pupates within the shoot about the end of July, and the insect remains in the pupal state all through the heavy rains and winter months, the mature beetles emerging the following June. This insect is capable of doing a very considerable

* *Vide* Injurious Insects of Indian Forests, pp. 52—55.

amount of damage to the bamboo which grows socially over large areas in the Chittagong Hill Tracts and areas to the east. A severe cyclone swept up into this region in October 1897 and cleared for some distance a path through the forest in the hills. The succeeding year the muli bamboo came up in dense masses in this cleared area, and this abundance of their food plant probably caused the severe attack experienced from this insect in 1899 and 1900. I have no information as to the abundance of the insects since this latter year.*

Another genus of small weevils named *Apoderus* defoliates trees by laying an egg in the apex of the leaf and then rolling it up into a roll or ball. Species of this genus have been observed defoliating the sissu, *Quercus incana*, *Q. dilatata*, *Prunus padus*, hazel, *Anogeissus latifolia*, &c., the species collected being found in places as far apart and under as varying conditions as obtain in the Jaunsar Hills and the Sutlej Valley in the N.-W. Himalayas on the one hand and the forests of the Satpura Range in the Central Provinces and the Coimbatore Hills in Madras on the other. In ovipositing the female deposits one egg apparently usually, if not invariably, at the apex of the upper side of the leaf and to the right of the mid-rib. It then cuts the leaf across about the middle or near the base, either on both sides of the mid-rib, leaving the latter intact, or else right across from one edge to the other, leaving a small portion at one side uncut. The cutting is done first and the egg laid at the apex afterwards. The cut portion of the leaf is then folded inwards down the mid-rib and the leaf is rolled up from apex downwards into a little roll, the edges being neatly tucked in on either side. The roll hangs to the untouched part of the leaf till it dries and then drops to the ground. The larva, on hatching out, feeds upon the store of food thus provided for it and probably pupates in the ground. †

The seed of both oak and sal is attacked by weevils and ruined.

An as yet undetermined species of weevil was recently found by Mr. B. O. Coventry attacking the oak, *Quercus incana*, about 80 per cent. of the seed crop of the trees round Mussoorie being destroyed in 1902. ‡ In this case the eggs would probably have been laid near or in the flowers, since the grubs were found riddling the acorns and immature and mature beetles were cut out of these in June. Mr. Coventry says that he was led to this observation owing to his noticing the general absence of natural regeneration of this oak. He collected a large number of acorns to test how many were sound. The reason for the unsoundness soon became obvious. If others will follow this lead we shall know more about the reasons for the absence of natural regeneration in our forests.

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* *Vide* Departmental Notes on Insects that affect Forestry, No. 2, p. 193.
† *Vide* Departmental Notes on Insects that affect Forestry, Nos. 1 and 2.
‡ *Vide* Indian Forester, Vol. XXVIII, No 10.

The mango weevil, *Cryptorrhynchus mangiferæ*, lays its egg in this way in the flowers of this tree and the young grubs get enclosed in the young fruit, in which they burrow about and feed and finally change to pupæ. The beetle on maturing bores its way out. *

FAMILY SCOLYTIDÆ (BARK-BORERS).

Small beetles, often very minute. Cylindrical in shape and generally dark brown or black in colour. The head is only prolonged into a very short beak and often not at all; antennæ are short, with a broad club which is elbowed and inserted close in front of the eye, which is often hollowed out to allow of the insertion of the antennæ. The antennæ do not fold back into grooves. They may be considered to consist of three main divisions—1st, the portion joining on to the head, which is the lower part of the elbow and consists of only one long joint called the *scape;* 2nd, the *funiculus* consisting of as many as seven joints or fewer; 3rd, the *club*, which may be solid or divided by transverse divisions, and varies greatly in shape. The antennæ are of importance since they are used in the classification of the family. These elbowed antennæ and four-jointed tarsus distinguish these beetles from *Bostrichidæ* which they greatly resemble. Prothorax is generally very long, often forming half the total length of the insect. Elytra cover the whole abdomen. The tibiæ are flattened laterally and in the majority the front tibiæ are set with spines on their outer edges; the third tarsal joint may or may not be bi-lobed. The larvæ are small white curved grubs resembling bostrichid grubs but differ in being legless. These insects feed as a rule in woody plants either in the bast layer and sapwood or tunnel right into the heart of the tree. The female burrows through the bark to lay her eggs, and does not usually lay them in crevices outside, as is the case with buprestids and longicorns. The beetles only appear for a short time for egg laying, but during this period they are often present in large numbers. The bark forms (*i.e.*, those which lay eggs in the bast layer) of this family may be either monogamous or polygamous.

In the monogamous forms the female usually pairs outside the tree and then bores through the bark and proceeds to make a gallery in the bast and sapwood in some definite direction, which is always the same for the same species. The beetle may take some days over this. As she bores she makes a series of small depressions, in each of which she lays an egg as she goes along. The grubs on hatching out make a gallery at an angle from the mother boring. When full fed they enlarge the end of their galleries into a pupal chamber, which may be either in the bast or may be bored into the sapwood. The larval galleries may differ in length and also in direction. The female beetle usually starts

* Vide *Injurious Insects*, pp. 55 57, Plate III, fig. 1, a, b, c, d.

the gallery, then attracts the male near the entrance hole, pairs, and then finishes the egg gallery.

In the polygamous forms the male beetle tunnels through the bark till it reaches the sapwood, in which it bores a small depression, which is the pairing chamber, and there remains. The females come to him, are fertilized, and then bore galleries leading off from the pairing chamber. On either side of these galleries they bite out small depressions, laying an egg in each. There is usually only one entrance hole by which the beetles enter. If the egg gallery made by the female is a long one, she bores ventilation holes horizontally through the bark here and there to the outside. The shape and length of these galleries is, in the cases of the Indian forms at present studied by the writer,* always the same for the same species of beetle. The dead body of the female is often to be found at the end of the egg gallery, as she dies as soon as she has finished this work. The egg gallery may or may not be blocked up with wood dust by the beetle.

This family contains numerous species which are destructive to trees, and research is showing that they probably play a very important part in the Indian forest, attacking both broad-leaved and coniferous trees. It may be mentioned here that this Family is almost entirely unknown both economically and scientifically. Since he has held the post of Forest Entomologist the writer has become acquainted with over 50 species, mostly new, and from what he has been at present able to study of their habits, the economic importance of thoroughly studying this important family of pests cannot be too strongly urged. The damage is done by the beetles, and the larvæ resulting from the eggs laid by them, boring beneath the bark in the bast layer, thus destroying this latter and leaving an indelible impression of their former presence either in the bark, or in the sapwood, or both, of the tree. When severe attacks have been experienced, if the bark be removed, both it and the sapwood will be seen to be completely covered, sometimes from the top to the base of the tree, with the galleries of the beetles. Now, as in making each of these galleries a certain amount of cambium has had to be destroyed, it follows that the strength of the tree has been lessened thereby, and when the attacks are on the scale described the tree will die. The insects do not usually attack healthy trees, but choose either newly felled or sickly ones in which the flow of sap is less strong. When the beetles are however very numerous, and no sickly trees or newly felled ones are available, they will attack healthy ones. Numbers are drowned in their burrows by the flow of sap put out by the tree in answer to the attack, but the flow becomes gradually weaker and weaker and the beetles finally kill the tree.

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* *Vide* Departmental Notes on Insects that affect Forestry, No. 2, in which a number of new forms are described.

The family may be divided into three main sub-families: the *Scolytini*, *Hylesini* and *Tomicini*.

The *Scolytini* can be distinguished by having the end of the abdomen flexed upwards and the tibiæ are entire on their outer edges and end in a hook. The genus *Scolytus* has been found to attack the deodar in India. The following is the life-history of one of the species, *Scolytus major*, MS.* The beetle is a monogamous one, the female pairing with the male outside the tree. The eggs are laid in the bast and sapwood, and to do this the beetle bores horizontally through the bark, the entrance hole being generally beneath a branch or flake of bark, until she reaches the cambium layer. The female then turns and bores her egg-gallery in an upward direction, grooving both bark and sapwood. This egg gallery consists of a number of small continuous zig-zag curves taken vertically up the tree. On either side of the groove indentations are cut and an egg is laid in each, from 60 – 70 being laid. The larvæ, on hatching out, bore away from the mother gallery at various angles, so that the figures impressed on the wood and bark consist of a number of radiating larval galleries, longer than the female gallery, which give off from the central mother tunnel. This plan of gallery is very characteristic of the genus *Scolytus*. The beetles oviposit towards the end of May, the larvæ are full grown in a month, and the mature insects issue during June and July and at once pair and lay eggs, which produce a second generation of the pest the same year, *i.e.*, fresh beetles mature about October. A closely related species, *Scolytus minor* MS., smaller than the last, is usually found in company with it and lives in exactly the same manner. Its galleries are smaller and fewer eggs are laid.

The *Hylesini* may be distinguished from the *Scolytini* by having the abdomen flat beneath instead of flexed upwards, whilst the tibiæ are toothed on their outer edges. This division contains both monogamous and polygamous forms. Species of the former have been found by the writer,—to give but two instances,—attacking sal trees in the Siwaliks and *Anogeissus latifolia* in the Coimbatore forests (in Madras) in a very similar manner. The female beetle after pairing bores through the bark down to the cambium layer and then mines out in this and the sapwood a short straight egg gallery parallel to the long axis of the tree. Eggs are laid in notches on either side of this gallery. The larvæ on hatching out bore away at an angle to the egg gallery and the pattern produced is not unlike that made by a *Scolytus*. The sal beetle here described has three if not four generations in the year. A monogamous species of *Hylastes* has been discovered in the N.-W. Himalayan forests. *Hylastes* sp. bores into the dying and dead wood of blue pine and spruce trees. The beetles pair inside the

* This beetle is allied to *Scolytus destructor* of Europe, and is probably new to science. For further information on its life-history, *vide* Departmental Notes on Insects that affect Forestry, Nos. 1 and 2.

wood and the female then continues the tunnel and lays eggs in small offsets eaten out at right angles from it.

Amongst the Indian polygamous forest *Hylesini* as yet known there are species of *Polygraphus* and *Pityogenes*, etc.* Three species of *Polygraphus* are to be found attacking the blue pine, two of which also attack the deodar and spruce. The largest one, *Polygraphus major*, MS, confines itself to the tops and branches. There is a central pairing chamber from which usually three egg galleries are bored. The larvæ feed wholly in the bast layer but pupate in the sapwood, boring a depression or hole in it. There are at least three generations of the insect in the year.

The life-history of *Polygraphus minor*, MS., is very similar save that it practically confines itself to the main stem of the tree, where it is almost invariably the companion of the blue pine *Tomicus* (see below).

Pityogenes coniferæ, MS., is a minute beetle which has usually 5—6 egg galleries radiating from the central pairing chamber. It often pupates in the sapwood, and is to be found in the blue pine and deodar—at times in enormous numbers. It has at least three, and probably more generations in the year.

The *Tomicini* are distinguished by having the ends of their elytra truncate, the head is spherical and hidden beneath the prothorax, which is often covered with projections and asperities; the third tarsal joint is simple. Several species of this division of the *Scolytidæ*, both monogamous and polygamous forms, are also already known in India.* Amongst the former may be mentioned members of the genus *Cryphalus*. These beetles are very minute and are generally to be found in the smaller branches or right at the tops of saplings. They lay their eggs in the bast layer and the larvæ, on hatching out, feed there. It is not improbable that it will be found that most forest trees in the country have a member of this genus present in the bast layer of their branches. Species have already been found infesting the following trees:—Teak, *Boswellia serrata*, spruce, *Pinus longifolia*, and deodar.

An example of a polygamous beetle of this division is the Blue Pine *Tomicus*, *Tomicus* sp., which is at times very abundant in blue pine and spruce trees and is a source of very considerable injury to them. The beetles commence laying the first batch of eggs of the year at the end of April or in the first week of May. The male bores into the bast layer and makes a pairing chamber in the sapwood; the females enter, and after pairing with the male mine away from the pairing chamber, their egg galleries running more or less in the long axis of the tree; from three to five such galleries are made, eggs being laid in notches at their sides. The larvæ, on hatching out, feed in the bast layer and sapwood. They pupate in the bast. Three if not four generations of these beetles

* *Vide* Departmental Notes on Insects that affect Forestry, No. 2.

are produced in the year, and at times they swarm so plentifully that the inner surface of the bast and the sapwood appear to be almost black with beetles.

FAMILY PLATYPODÆ (PLATYPIDES SOME AUTHORS).

These insects are the most aberrant of all *Rhynchophora*, the head being very short, flat in front, with the mouth placed on the under side of the head, there being no trace of a rostrum; the tarsi are elongate and slender, the third joint not at all lobed, whilst the true fourth joint is visible. The beetles are of a narrow elongate form, and from the above description it will be seen that they have not the appearance of *Rhynchophora*. Some authors treat them as a sub-family of the *Scolytidæ*. From my own observations of several new species found in India I incline to the side of those scientists who consider that these beetles should be placed in a separate family. The larvæ are white with a straight almost cylindrical body which terminates in an oblique truncation.

These beetles bore into the wood of trees and stumps, and may not unlikely prove to be somewhat numerous in the country. A species *Diapus impressus* was reported some years ago as attacking oak stumps in the North-West Himalayas The writer has since found this insect in considerable numbers in felled *Quercus incana* trees in the same locality. The beetles drill cylindrical holes right down into the heartwood of the tree and then lay their eggs at the bottom. The larvæ on hatching out feed upon the solid wood. Other species of this family new to science have been found in the same locality in dead spruce wood and drilling holes down to the heart of large newly-felled deodar trees. Another species has been found tunnelling into newly-felled *Shorea talura* trees in the Coimbatore forests of Madras, whilst a fourth bores into *sundri* wood (*Heritiera littoralis*) in the Sundarbans.

FAMILY BRENTHIDÆ.

Elongate beetles. The rostrum is straight, not bent over at an angle as in weevils, and often very thick. The antennæ are not elbowed. This is a tropical family of beetles about which very little is at present known in India. Some are stated to be wood feeders, whilst other forms are predaceous, their larvæ entering the burrows of wood-eating beetles to search and feed upon their larvæ. The rostrum is often used for boring holes in wood or bark, an egg being subsequently laid in the hole so made. The males of these insects often differ entirely in appearance from the females.

TRIMERA.

The tarsi are apparently three-jointed. Other characters are variable.

FAMILY COCCINELLIDÆ (LADY-BIRD BEETLES).

Small, often somewhat brightly-coloured beetles with the elytra spotted; first two joints of the tarsi are pubescent beneath. Head is concealed by the thorax. Antennæ are slightly club bed

The larvæ vary in shape and markings, some being small coloured grubs covered with spines; they are often very conspicuous. When changing to the pupal state they often attach themselves to a leaf of a plant. One small division of the family are plant feeders, but the greater bulk prey upon other insects and are exceedingly carnivorous. They destroy wholesale plant lice, scale insects, etc., which are injurious to cultivated plants. In this way they do immense service to man. A study of this family in India is likely to prove of the very greatest use, since it is probable that it contains a number of members which are most valuable allies both to the forester and the agriculturist One instance of this kind, recently discovered, will be given here, the life-history being that of a lady-bird beetle *Coccinella* sp., predaceous upon a *Monophlebus* scale insect, *Monophlebus Stebbingi*, which during recent years has appeared in enormous numbers and committed serious injury in the Siwalik and adjacent sal forests in the United Provinces and Punjab. The life-history of this predaceous beetle is very simple. The female monophlebus scale (whose life-history will be described in a subsequent part) first appears upon the leaves in the cold weather months, December and January. By the middle of March it is half-grown, having by then descended from the leaves to the twigs. The small active black or grey coloured larvæ of the lady-bird beetle are then to be found running over the trees or feeding upon the scales. They suck the soft fat scales quite dry leaving only a shrivelled skin. When feeding upon the coccid they attach themselves to the branch by means of a small sucker-pad arrangement they have at the end of their bodies. This attachment is so powerful that the scale, which is several times larger than the coccinellid larva, is quite unable to drag the grub off and thus escape. Towards the end of March and on into April the larvæ begin to change into small crimson pupæ. In doing this they first attach themselves to a leaf or branch by the sucker-pad and remain projecting out at an angle from it. After 24 hours the skin splits down, shrivels back, and discloses the crimson pupa sessile on the leaf or branch. After 7 to 8 days the skin of the pupa splits down in front and the small red beetle crawls out. It is first covered with a white down, but soon loses this, darkens to a dark red with six black spots upon the elytra. The beetle also feeds upon the scale. It pairs about the end of April and then lays eggs. The life-history for the rest of the year has not yet been studied.

Useful Coleoptera.

Amongst the *Adephaga* the *Cicindelidæ* and *Carabidæ* are useful predaceous families containing many carnivorous forms. In the *Clavicornia* the *Silphidæ* include the useful carrion and burying beetles and the *Staphylinidæ*, *Histeridæ*, *Nitidulidæ*, and *Trogositidæ* containing numerous forms, predaceous upon bark-boring and wood-boring pests. Under the *Serricornia* the

larvæ of the *Malacodermidæ* are supposed to be predaceous, whilst the family *Cleridæ* are likely to furnish the Forester with several useful allies, the *Clerus* sp. beetle described as feeding upon several scolytid pests being of inestimable value in the forest. Some of the *Elateridæ* larvæ may prove to be useful in this connection. The metallic-coloured elytra of the *Buprestidæ* are used to some extent in Southern India for ornamentation purposes and also as caste marks, whilst the *Cantharidæ* contains beetles such as the oil and blister beetles, which are used in medicine. Little is at present known about the *Brenthidæ* in India, but the family is known to include predaceous forms. The *Coccinellidæ* are likely to prove of very great value, as the family contains many excessively predaceous insects.

The Harcourt Working Plan. *

In the Department of the Eure, at Harcourt, the National Society of Agriculture possesses an estate of over 400 hectares; 100 hectares surround the chateau; 350 acres of forest form two outlying blocks. The soil, a clay with more or less sand, is covered in places by mud brought down from the plateaux, and is by no means flat. The management is perfect, cultivation is restricted to the alluvial deposits, the sandy clay is covered with splendid oak and beech forest, and a portion recently cleared displays a fine young crop of Scotch pine. The present management was explained to the Society by M. Bouquet de la Grye as follows:—

"The working-plan of M. Gurnaud was applied from 1890 to 1901, twelve years, the full rotation adopted by him. The results seem to be favourable, but this is not a proved fact, because certain special fellings of Scotch pine made during the first period render it impossible to compare the past stock with the present. It has, moreover, appeared to us that the necessity of undertaking a full enumeration of a forest of over 400 hectares at the close of each period was a very large order, and that the sale in small lots of coppice material that has become almost valueless through the heavy fall in the price of wood fuel was no longer advantageous. These considerations induced us to ask the Society to sanction some modifications in the plan without changing its essential features. As the treatment proposed by us is very simple and applicable to the stored coppices of many private owners who may desire to transform them into high forest, or at least into standards over coppice, we have thought that an explanation may be of interest.

* Translated from the *Revue des Eaux et Fôrets* for 1st August 1902, by F. Gleadow, in the hope that it may be found both new and interesting. It suggests ideas outside the usual grooves, and is not without its bearing on the treatment of high forest in general. The name of M. Bouquet de la Grye commands esteem throughout the world.

"M. Gurnaud's division into three series is retained. Each of these series is divided into coupes laid out on the ground. The first series has 12 coupes, the second has 15, and the third has 12. The first series according to M. Gurnaud had 20 coupes, but as eight of these coupes have been clean felled and are useless for the present, they are set apart as a reserve for the future. The order of working for all three series being the same, it will suffice to describe that of one only.

"First we enumerate all trees over 60 centimetres (24 inches) girth at breast-height. This is the high forest. From tests made, we assume that the annual increment of the high forest share is two per cent. or for 12 years 24 per cent. At the felling, the possibility (or possible yield) is 24 per cent. of the stock, calculated in cubic metres. The inventory is made by means of a table based on the (inexact) assumption that trees of the same girth at breast-height contain the same quantity of timber. As this table is only used for subsequent comparisons, its accuracy is sufficient. It is not used for sales. For these the usual commercial methods are employed. In making the felling, 24 per cent. of the stock is chosen from the dominated, defective, and inferior trees. These are then valued on commercial principles, either standing or felled, according as the felling is done by the purchaser or by the owner.

"The coppice portion, consisting of shoots and standards below 24 inches girth, undergoes a strong thinning or clearing with the object of freeing all the stems which are suitable to grow up into the high forest stage. This thinning is a most important operation, and must therefore be done by the owner, or at least by workmen under his pay and supervision. The undergrowth, shrubs, and other elements of soil-protection must be carefully preserved, and this requires the eye of a forester.

"Twelve years later, when the second felling comes round, the same stock-taking is repeated. If the stock, valued in the same manner, amounts to a nearly similar quantity as at first, there is proof that the increment has been truly estimated. If the new stock is greater, the increment has been more than the two per cent. per annum, and the owner may either increase his felling or devote the gain to the enrichment of the high forest portion. If the new stock is less, the increment has been over-estimated, and the owner must reduce future fellings so as not to impoverish the forest.

"It is thus clear that each coupe is treated as an independent unit; instead of a general enumeration, the coupe of the year only is valued. The high forest portion can be felled either by owner or purchaser. The underwood should only be felled by the owner. This method of treatment, under which the yield is checked by the periodical verification of the increment, dispenses with many hypothetical calculations that are at present adopted in order to fix the exploitable age and the possible yield."

The Indian Pheasants and their Allies.

BY, F. FINN, B.A., F.Z.S.

CHAPTER V.

KALIJES—(*continued from Vol. XXVIII, p. 446*).

THE height of perplexity has, I believe, been exemplified by a blind man looking in a dark room for a black hat that is not there! Somewhat similar is the state of mind induced by the study of the Kalij pheasants of this Empire. Once we get away from the three species I dealt with in the last chapter, I doubt very much if the birds themselves know to what species they belong; at any rate, if they do, they are singularly free from any restrictive rules about inter-marriage, and the result is a collection of mongrel hybrids exceedingly interesting to the philosophic naturalist, but maddening to the casual observer who wants to name what he shoots.

On the principle of proceeding from the known to the unknown, I shall first describe the first species about which no doubt exists, and then proceed to the consideration of those concerning which authors are not agreed. I may, however, first of all recall to mind that the males of all the kalijes now to be dealt with differ markedly from those previously described, in having the breast-feathers of the ordinary rounded shape, not narrow and pointed. Moreover the breast is always mostly black, generally completely so.

THE BLACK-BREASTED OR PURPLE KALIJ.

Gennaeus horsfieldi, Blanford, Faun. British India, Birds, Vol. IV, p. 92.

Native names :—*Mathûra*, Chittagong and Sylhet; *Dúrûg*, *Dirrik*, Garo Hills; *Dorik*, at Dibrugarh. The last name seems commonly used by Europeans.

This is a bird of similar type to the light-breasted kalijes hitherto dealt with, with a narrow projecting crest, and rather short hen-like tail. The cock is altogether of a glossy purple black, except for the white barring on the rump which he has in common with two of his allies above mentioned.

The hen is just like the hens of the previous kalijes—brown, with each feather tipped with a lighter shade, and with the tail feathers black, except the top or central pair.

The bill is horn-colour, face red, and legs drab or grey.

The dimensions are also as in the previous species, the cock being about two feet long and the hen about twenty inches. This bird's range extends from the lower hills of East Bhootan and the Daphla country, north of the Assam valley, throughout the ranges to the southward to Chittagong, North Arrakan, South Manipur and Bhamo. Its eggs, which resemble those of the preceding kalijes, have been found in Sylhet towards the end of March. If has been tried as a game-bird in English preserves, but though it throve well, was killed off again as a nuisance, being very pugnacious to the true pheasants, hard to put up, and flying dangerously low for shooting when it could be made to rise.

THE LINEATED KALIJ OR BURMESE SILVER PHEASANT.

Gennaeus lineatus, Blanford, Faun. Brit. Ind., Birds, Vol. IV, p. 92.

Native names :—*Yit*, *Kayit*, Burmese; *Rak*, Arrakanese; *Synklouk*, Talain; *Phugyp*, Karen.

This is a slightly larger bird than the last, but of the same type as regards the narrow stiffish crest and rather short tail; its colouration is, however, of a quite different character.

The male is blue-black only on the crest and on the under parts from throat to beak; the flanks are also black, with white streaks in the centres of the feathers, which streaking may extend over all of the breast also. But the upper plumage, wings, and tail, are of a grizzly grey or pepper-and-salt colour, produced by fine zig-zag black and white pencillings, which get stronger and coarser on the quills of the wing and tail. The topmost or centre tail feathers, however, are pure white on their inner webs and tips, contrasting well with the rest of the plumage.

The hen is brown, with the head, neck, upper back, and breast distinctly streaked with white, the white marks being

V-shaped on the back of the neck and shoulders. Her centre tail feathers have the inner webs and the tips buff, corresponding to the white of the same pair in the cock; and the outer pairs are black, marked with brown, and pencilled with wavy white lines. She is thus easily distinguishable from the hens of the previous species.

The face is red, as usual, in this species, and the bill greenish horn-colour; the eyes, however, vary from red-brown to white, and the legs from drab to flesh colour.

This is the kalij of Burma, and it extends to south-western Siam. It frequents hilly ground, and keeps to cover, being an inveterate runner and skulker. It breeds in March and April, the nest being merely a hollow lined with a few dead leaves, and containing seven eggs of a pale buff colour.

In order to understand the kalijes of this group, it will be necessary to describe a species which is not Indian, but which with the extension of our Empire or of its own ranges may come to be a British subject, and is at all events better known generally than any other kalij.

This is the *Silver Pheasant (Gennaeus mycthemerus)* of China now rare in a wild state in that country, but very widely known as an aviary bird, as it thrives better than any other pheasant in captivity. In this bird, which is larger than any of our species, the male has a long full drooping crest and a very long tail, reaching two feet, and gracefully arched and tapered; but the *feathers composing the tail are flat and lie vertically* and back to back as in other kalijes. The crest, under-parts, and flanks in the cock are blue black, and the upper plumage, wings and tail pure white, with fine hair-like black pencilling, which becomes strong and bold on the wings and side tail feathers. The centre tail feathers are plain, and at a little distance the whole upper plumage looks white.

The hen has a very short crest and a moderately long, closely-folded tail. She is of a plain uniform brown, with the side tail feathers boldly pencilled with black and white.

Both sexes have bright red legs, pale green bills, and red faces, the male's face having a beautiful velvety appearance. He is, altogether, a most lovely bird, unequalled in the whole family for grace of form, while his colouring, though so chaste and simple, is particularly striking. He is no better than other kalijes as a sporting bird, but there is more meat on him, and as he is unequalled among game birds as a landscape ornament, I should strongly advise his introduction in India, where kalijes of any sort can live, as one may as well have a very beautiful bird about as an ordinary looking one.

CRAWFURD'S OR ANDERSON'S SILVER PHEASANT.

Gennaeus andersoni, Blanford, Faun. Brit. Ind., Birds, Vol. IV, p. 94.

This species, which is rather doubtful and has been described under several names, is intermediate between the two last. The tail of the male, although not so long as that of the Silver Pheasant of China, is nevertheless considerably longer than the wing, and curved; the crest is full and drooping. This crest, with the under-parts and flanks, is black with a blue gloss, as usual; the upper parts appear grey at a little distance, but close at hand are seen to be boldly and clearly marked with concentric lines of black and white, equal in breadth and resembling a curved V or a Gothic arch in shape. The accuracy of the pattern is something remarkable, and has a very beautiful effect. On the quills of the wing and tail the marking becomes a rather irregular pencilling, and on the inner webs and tips of the middle tail feathers the black pencilling dies away altogether.

The hen is plain brown almost throughout, including the side tail-feathers, but is marked on the breast with V-shaped white streaks.

The cock is two-and-a half to three feet long, of which more than half is tail. The wing measures about ten inches.

This is one of the doubtful species to which I alluded above, as are also those which follow. Only a few specimens have been obtained, and these appear to differ considerably. The type of the species, however, obtained by the late Dr. Anderson in the Kachin Hills, closely agrees with birds from the Ruby Mines in Burma and with others obtained by French naturalists from Annam. I was able to observe the last in Paris some years ago, and there saw the hen. Dr. Anderson's bird, which is still in the Indian Museum, had flesh-coloured legs, but the others I have seen had red ones like the Chinese Silver Pheasant. Several skins collected by Captain W. G. Nisbett in the Kachin Hills, north of Bhamo and east of Myitkyina, show the most remarkable gradations between this species and the Purple or Black-breasted Kalij (*Gennaeus horsfieldi*), and the two species evidently interbreed there, the Purple Kalij strain predominating on the lower ground and the Silver Pheasant on the higher. One such hybrid, with the white pencilling on the upper surface less strong than in the true *andersoni* and showing white rump bars, has been called *Gennaeus davisoni*. Mr. Oates considers this form the true *andersoni*, and calls the Ruby Mines birds *Gennaeus rufipes*. All I can say is, however, that what I have above described as *G. andersoni* corresponds with the typical specimen in Calcutta and with the figures which have been published to accompany accounts of that species, so that there should be no doubt about it.

Dr. Blanford, in the *Fauna of British India*, suggests that *G. andersoni* may after all only be a cross between the Lineated Kalij and the Chinese Silver Pheasant; and certainly there is a stuffed specimen of this cross in the Paris Museum which nobody could call anything else but an Anderson's Silver Pleasant if they did not know its origin. On the other hand, the uniformity of the type in several specimens might be used as an argument for its distinctness. Many hybrids, however, are known to be very uniform in type, especially those between the Golden and Amherst Pheasants, and the goldfinch and bullfinch. Moreover, intermediate forms appear to occur between Anderson's and the Lineated Pheasant, and also between the former and the true Chinese Silver Pheasant, so that on our eastern frontiers there seems to be a great deal of confusion among these birds which has not yet been cleared up. Experimental breeding in confinement ought to settle the matter, and with birds so easily kept and studied as are the kalijes the problem might be solved in a few years.

I have dwelt on this point at such length because the same remarks apply to the other doubtful forms I shall now describe, though none of these are so interesting as the Anderson's Silver Pheasant, which is really a very beautiful bird in its own way and quite unlike anything else, so that if it really is a hybrid it is a very remarkable product.

CUVIER'S KALIJE.

Gennaeus cuvieri, Blanford, Faun. Brit. Ind., Birds, Vol. IV, p. 93.

In this bird, which exactly resembles the Purple Kalij in shape, the plumage is also much like that of that bird, being mostly purple black with white bars on the rump; but the upper parts, wings, and tail are all regularly but finely pencilled with white lines. The marking, in fact, is that of the Chinese Silver Pheasant reversed. All the tail feathers are pencilled in this way, from the centre pair to the outside, whereas in most of these pencilled pheasants the marking differs on the different feathers of the tail.

The hen is brown with lighter edges to the feathers, like that of the Purple Kalij, but her outer tail feathers, instead of being plain black as in the hen of that species, are pencilled with fine white lines like the plumage of her own mate.

This species, which resembles the Purple Kalij in size, seems to be found in the most typical form in the Chin Hills; at any rate some specimens I have examined from there agree remarkably in their plumage. The figure given by Temminck, who first described *Gennaeus cuvieri*, also agrees closely with the Chin Hills birds; but Temminck could give no locality for his specimen.

At the same time, these Chin Hills kalijes with fine white pencilling on black may be merely hybrids between the Purple and the Lineated Kalij, as Dr. Blanford thinks. They certainly are just what one might expect from such a cross.

Oates's Kalij.

Gennaeus oatesi, Blanford, Faun. Brit. Ind., Birds, Vol. IV, p. 94.

This is still more like the Purple Kalij, not only resembling it in shape and size, but being almost completely blue black with white rump-bars. But there is on the upper plumage a scanty and broken pencilling, or rather peppering, of white, giving it a frosted appearance; and the inner webs of the middle tail feathers are nearly white, as in the Lineated Kalij.

The hen is like that of the Purple Kalij, but has the black outer tail feathers mottled with black and chestnut, and the inner webs of the centre tail feathers pale buff or green colour.

This seems to be the kalij of the Arrakan Hills, two of Blyth's old specimens, in the Asiatic Society's collection deposited in the Indian Museum agreeing with the above description. The description which Dr. Blanford gives of *G. cuvieri* in the place above cited, also agrees better in some respects with this bird than with Temminck's. But he considers this form also a hybrid, as did Blyth, who identified it with Temminck's *G. cuvieri*. And two other specimens of Blyth's from Arrakan are most obviously hybrids between the Purple and Lineated Kalijes.

Several other pencilled kalijes have been described, but I have contented myself with noting the forms I have been able to make out personally, as, except the Purple, Silver, and Lineated birds, all the species with which we are here concerned are very doubtful. Sportsmen should preserve, however roughly, the skin of any pencilled kalij they may shoot in out-of-the-way places, or at least take photographs of such, the black and white markings lending themselves admirably to photographic reproduction. The dimensions and locality should of course be noted. By the collection of such evidence we may at length find out how many species there really are, but I fancy experimental breeding would determine the point a good deal sooner.

The Fire-backed Pheasant.

Lophura rufa, Blanford, Faun. Brit. Ind., Birds, Vol. IV, p. 87.

After such a terribly mixed up lot as the pencilled kalijes, it is a relief to come across a bird which is very distinct from everything else, as is the present one. In its general appearance the Fire-back resembles the shorter tailed kalijes, but the male has a different style of crest, this being erect and brushlike, and composed of feathers which are bare-shafted at the base. There does not, indeed, seem much reason for separating the few species of

Firebacks from the kalij genus. In the male of our only species, the general colour of the plumage is metallic purple; the lower back is fiery copper red, and the two centre pairs of tail feathers and part of the next pair are white. There are also some white streaks on the sides of the body.

The hen is chestnut-coloured with white edges to the feathers of the neck in front; below this the feathers are black, still with white edges, and the pattern extends along the flanks; the centre of the belly is plain white.

The bare skin of the face is bright blue and the eyes red; the bill all white in the male, but brown below in the female. The legs and feet are bright red.

The cock is a large bird, measuring twenty-eight inches in length, of which less than a foot goes to the tail; the wing is almost a foot long, and the shank nearly five inches. The hen is less than two feet long, with a ten-inch wing and tail of only eight inches.

This pheasant only just comes within our area, inhabiting Sumatra and the Malay Peninsula, whence it extends into the most southern part of Tenasserim. It inhabits evergreen forests, and is found in small parties of about half-a-dozen, though the males are sometimes solitary. They buzz with their wings like the kalijes. Like them also, they are vicious birds, a very fine specimen shown me recently by a native gentleman in Calcutta, which had been kept for more than twelve years, was confined in a cage for attacking one of the servants—whose wrist it had ripped open with its spur—when allowed to run at large. Another of the species, now in Mr. Rutledge's possession and also allowed liberty was, when I last saw it, walking round and round an old native in a manner which boded an attack. It was interesting to see that the bird's fighting attitude was exactly like what would be the show position before a hen. The blue face skin was expanded, and the slanting pose assumed, so as to keep the copper back always in full view of the spectator on whom the bird was intent.

Little seems to be known of the Fireback altogether; our information about its breeding has been furnished by a captive hen, which laid, in July, a buff egg a little over two inches long. All the Firebacks seem rather scarce in captivity, so that specimens would be acceptable to any zoological garden

(To be continued).

Professor Bailey on the want of a State Forest.

COLONEL BAILEY, in opening the Forestry Class, said the present was the twelfth occasion on which he had addressed an introductory lecture to the students of that class. In France, Germany, and other foreign countries, he went on to say, they had fully equipped special schools with woods in which practical instruction was given, and the students' whole time, for three or more years, was at the disposal of the professors. At Cooper's Hill candidates for the engineer, telegraph, and forest department of India received their training, and the course for forestry students extended over three years, one year of which was spent in practical work in German and French forests. In Edinburgh they were limited to a course of one hundred meetings, and the students of the class were for the most part engaged in other university work, so that the practical work was unavoidably limited to excursions on Saturdays to woods in the neighbourhood, which had not been managed on correct principles for a sufficiently long time to render them suitable object-lessons to the class. The want of a State demonstration forest was very badly felt. Woods privately owned could never answer the purpose satisfactorily. In consequence of representations made by the Arboricultural Society, a Departmental Committee had been appointed by the Board of Agriculture, and it might be hoped that one result of that committee would be the provision, within a convenient distance of Edinburgh, of a State area in which practical instruction could be given to this class. Visits to Continental forests would, however, be desirable for some years to come, until well developed middle-age and older crops could be shown here. The prospects now offered to foresters in this country were not encouraging. That was largely because their woods had not, generally speaking, been managed on business principles, with the sole object of making them pay a profit from the sale of their produce. For that and other reasons they had not, in the past, yielded the returns they would have rendered under different management. That result, however, had not been attributed to its true cause, but had been falsely ascribed to defects in their soil and climate, the non-existence of which might be concluded from the splendid specimens of isolated trees which adorned their parks and policies. Their woodlands had great potential value, which had not yet been generally recognised by their owners and the public. But the old views on many points connected with British forestry were rapidly losing ground; and

as soon as a fair proportion of their landowners began to realise the possible value of their woods, and to recognise forestry as a science, they would begin to pay adequate salaries to trained men. The certain falling off in their supplies from abroad would enhance the market value of home-grown timber, and that again would add to the value of their woods, and render their owners more desirous of placing their management on a sound basis.—*The Timber Trades Journal.*

Forest Destruction by Insects in Norway.

CHRISTIANA, *December 20th* 1902.

OUR big forests in Osterdalen and Solor have met with a fearful plague, and are in great danger of being destroyed.

A larva "furuspinner" (firspinner) appears in masses, and has already totally destroyed 6000 "maal" (one maal equals 1000 metres). It appears, besides, in abundance over an area of 60,000 to 70,000 maal, setting aside the areas where it does not appear so numerous. The hitherto caused damage can scarcely be estimated less than 300,000 kroner, to which comes the value of the infected and threatened areas. The value of these latter is estimated at 1,200,000 kroner. Under these facts—and in consideration of the rapid spreading the larva has had, and paying attention to—that we still only are in the beginning of its devastation—the forest societies are letting their daily work rest for getting time to fight the great danger only.

How rapid the larva has spread the following facts will show: In 1901 10 to 20 maal were destroyed; up to August 12th, 1902, 1000 maal; to September 26th, 1902, 2000 maal; October 8th, 1902, 3500 to 4000 maal; and to October 22nd, 1902 6,000 maal.

A petition has recently been handed to the Agricultural Department with a request, as soon as possible, to grant and pay 25,000 kroner, to the "Hedemarken Forest Society," who are willing to conduct the fight against the pest. This temporarily, 25,000 kroner, will be used for preliminary enquiries how the larvæ can best be destroyed.

The forest owners themselves are now preparing to protect their forests against the destroyers when they, in the spring, awake from their sleep in the bog. For instance, by glue-rings around the trunks, where the larvæ will then stick to when crawling up; or by digging trenches, with small deepenings, with food in, is an easier way to be able to destroy them. Isolation lines of glued laths will also be used.

The larva is very big, quite $2\frac{1}{2}$ inches long, and about a little-finger thick. It eats a fir leaf in five minutes, and 1000 fir leaves before changing into a butterfly. It was hoped that they would

perish during the winter; but the fact is that they easily stand 10 to 15 degrees. They are lying together in balls under the bog during the winter, and awake in April, when they at once go to their destroying work. It is pitiful to look at an area where the larva has stayed for some time. All is eaten—not a fir leaf left—only brown, brown, brown.

It is believed nature only destroys them by parasites (mushrooms), but only after a three years period; but as they, during three years, can waste big areas, of course, something must be done, and as fast as possible. To cultivate parasites will be tried, and spread them out over the infected forest. The last four dry years have caused this plague.

Perhaps the worst of all is that nothing will grow on the places where the larva has wasted.

The last time these pests appeared in such numbers was in 1812 to 1816, when big forests were destroyed.—*The Timber Trades Journal.*

VII.—TIMBER AND PRODUCE TRADE.

Churchill and Sim's Wood Circular.

London, January 12th, 1903.

East India Teak.—The importation of timber and planks has been:—

	1896.		1897.		1898.
	23,312 Loads	...	20,428 Loads	...	18,083 Loads
And the deliveries	21,941 „	...	18,410 „	...	18,526 „

	1899.	1900.	1901.	1902.
	12,835 Loads...	15,024 Loads...	12,860 Loads...	8,76[illegible] Loads
Deliveries.	17,017 „	...11,053 „	...13,807 „	...12,598 „

A comparison of the figures of importation, delivery and stock given in our tables reveals the fact that the London market for teak has been badly starved for supplies during 1902. An abnormal shortage of rainfall in Burma and Siam has resulted in a block of logs up country, which there has been no water in the rivers to bring down for manufacture to the shipping ports, and occasional heavy storms, causing sudden temporary floods, seem to have done more harm than good, by washing logs away altogether. A more normal state of things is thought now to have supervened, but the process of getting into working order again will be very slow, and in the meantime, stocks in the importing markets all over the world are being reduced to a minimum. Prices have risen slowly and with a good deal of hesitation throughout the year, and at its close are certainly not so high as might well have been expected under the circumstances—partly, perhaps, from sheer lack of anything to feed upon, for it

is difficult to raise prices without any wood to sell. In London the consumption remains at about the average of the two previous years, but is greatly below the figures of the years before that, when supplies were so much larger. Logs and planks have about maintained their relative position, the demand for the latter not having made any notable further advance during the year. The supplies from Java have been more ample, and, partly aided, no doubt, by the scarcity from the older sources, have advanced greatly in favour, and been saleable at fairly remunerative values. The demand for teak grows and spreads steadily, and although less is probably used in an individual warship than was formerly the case, many more warships are now built and planned, and the general use of the wood increases yearly.

ROSEWOOD—EAST INDIA.—There was a considerable increase in the imports last year, and the demand, although still small, was rather better. The bulk of the import was taken into consumption, but sufficient stock remains on hand to supply current inquiry, which is mostly for large prime logs of good colour. Prices kept fairly steady, and are now firmer at from £8 to £11 per ton.

SATINWOOD—EAST INDIA.—The heavy stock brought forward was increased by fresh arrivals in the early part of the year, and for several months sales were slow and difficult, only figury logs attracting attention. Later on, supplies being less and the demand better, considerable sales were made, and although stocks are now quite moderate, there is sufficient ordinary wood, but finely-figured logs are rather scarce, and continue to bring good prices. Quotations are from 6*d.* to 1*s.* per foot.

EBONY—CEYLON.—There was a considerable increase in the imports last year, but the demand remained inactive. Prime large logs were scarce, and the small lots sent brought full prices, but the bulk of the supply consisted of ordinary or poor wood, for which buyers could only be found occasionally, even at low prices, and the unsold stock is now rather heavy. Quotations are from £8 to £15 per ton.

EAST INDIA.—The imports were in excess of the previous year, but were still very moderate. The demand was steady, and prices kept firm for good wood, but lower qualities were weaker towards the end of the year. Quotations for average sizes are from £9 to £12 per ton.

PADOUK—EAST INDIA.—The import, although slightly larger than that of the previous year, was still very small, and sold readily at good prices. Supplies are now much wanted, as there is an active demand and scarcely any stock. For African there was more enquiry, but only one small parcel was sent here; this sold well, and the demand is increasing. Quotations for East India wood are from 5*s.* to 6*s.*, and for African from 4*s.* to 5*s.* per foot cube.

the prospective railway developments, and the re-equipment of the existing railways necessitated by the events of the recent war.

In respect to London *per se*, the imports into and deliveries from the London Docks during the twelve months ending 31st December 1902, shew as follows :—

Logs	5,420	loads imported, against	7,834	loads delivered into consumption.
Plank and conversions	2,844	„ „	4,283	„ „ „
Total ...	8,264	„ „	12,117	„ „ „

NOTE.—The above figures deal only with *landed* stocks, and are exclusive of the overside deliveries, which, although very important in quantity, are not noted by the Dock companies.

The Dock stocks at date analyse as follows :—

	5,394	loads of logs, as against	7,779	loads at the same time last year.
	2,706	„ planks „	4,115	„ „ „
	—	„ blocks „	12	„ „ „
Total	8,100	loads „	11,936	loads.

The past year has been characterised by a dead level of dullness throughout all departments of the timber trade, the demand having been of a monotonous hand-to-mouth character, with few forward contracts of any importance. On the other hand, the cost of most hardwoods, of which teak and mahogany are the leading examples, has steadily risen ; and American and Canadian woods have also advanced all round. With the possible exception of pitch pine the increased cost in all these woods has not been due to any artificial manipulation, but the legitimate result of light supplies and increased cost of forestry operations owing to the appreciation in value of land, the giving out of the old forests near the main streams, and, in the case of teak, increased royalties and Government restrictions on the depletion of forests. As populations grow in the countries supplying timber to Europe, there is a greater demand for the home needs of such countries, and the trend is to increase the cost to Europe for the decreased quantities to be shipped ; and although countries near home, like Russia, Norway and Sweden, may force down values by prematurely forcing on Europe more than it is in need of, time will surely, if slowly, bring about a permanently higher level of value, seeing that it is a generally accepted fact that nature is not replacing trees at the same rate as they are being cut down. Financially, the timber trade has continued to be sound, as the great dullness in trade has served to emphasize caution, rather than, as is sometimes the case, caused rash speculation in order to galvanize trade with the spurious activity which ends in financial trouble.

Market Rates for Products.

TROPICAL AGRICULTURIST.

January 1*st* 1903.

Cardamoms	...	... per lb.	1*s*. 9*d*. to 2*s*.
Croton seeds	...	... ,, cwt.	15*s*. to 25*s*.
Cutch	...	... ,, ,,	25*s*. to 30*s*.
Gum Arabic, Madras		... ,, ,,	18*s*. to 25*s*.
Do. Kino	...	... ,, lb.	$4\frac{1}{2}$*d*. to 7*d*.
India-rubber, Assam		... ,, ,,	2*s*. to 2*s*. 6*d*.
Do. Burma		... ,, ,,	2*s*. to 2*s*. 4*d*.
Myrobalans, Madras		... ,, cwt.	5*s*. to 6*s*.
Do. Bombay		... ,, ,,	4*s*. to 7*s*.
Do. Jubbulpore		... ,, ,,	4*s*. 6*d*. to 6*s*.
Do. Bengal		... ,, ,,	3*s*. 6*d*. to 5*s*.
Nux Vomica	...	... ,, ,,	7*s*. to 10*s*.
Oil, Lemon-grass	...	... ,, lb.	5*d*.
Sandalwood, logs	...	... ,, ton	£15 to £30.
Do. chips	...	... ,, ,,	£5 to £5 10*s*.
Sapanwood	...	... ,, ,,	£4 10*s*. to £5 10*s*.
Seedlac	...	... ,, cwt.	117*s*. 6*d*. to 120*s*.
Tamarinds, Calcutta		... ,, ,,	8*s*. to 10*s*.
Do. Madras		... ,, ,,	4*s*. 6*d*. to 6*s*.

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The Unity of Sylviculture.*

SYLVICULTURE is one. Professor Mayr of Munich, who emits this aphorism in the pages of the *Allgemeine Forest und Jagdzeitung*, means thereby to emphasise the unity of the principles of the art in all countries, however deeply they may have to be modified in order to meet human interest and local conditions. The author has travelled much. He has studied forests under the most various climates, and has deduced from his studies a series of general principles. A discussion of each of these would lead us too far, but a selection is here offered to the reader, who may make his own comments thereon.

1. When the mean temperature of the four months of most active growth falls to 10°C. the forest disappears or is represented by a poor stunted growth. This holds equally for Europe, Asia, and America in both hemispheres. Under the equator the limit of woody growth is at about 3500 metres† yet at this elevation it seldom freezes! (*Query.*—During the four months at 11,400ft. on the equator.—TRANSL.) The temperature of 10° is there nearly constant; the *annual* mean is that of the regions where in Europe the wine and tobacco prosper, yet wood will not grow. It follows that the 10° of the winter season do not count, and that the total temperature cannot serve to characterise the vegetable life.

2. In the northern hemisphere, when the mean temperature of May, June, July and August is between 12° and 15°, forest vegetation exists, and resembles that which is found in Germany

* Translated from M. A. Schaëffer in the *Revue des Eaux et Forêts* for 1st August 1902.

† Say 11,400 ft., but the translator has seen firs and bushes at between 12,000 and 13,000 in the Himalayas.

under similar climatic conditions. It is the zone of the fir and spruce in Europe, Asia and America. If, during the same months the mean temperature is between 15° and 18°, the locality is that of the beech, while the oak, maple, *tsuga* and *chamæcyparis* can also be grown. A knowledge of the summer mean is therefore fundamental when introducing exotics. Conversely, if a region produces naturally spruces, beeches, chestnuts or what not, a close idea can be formed of the mean summer temperature. This is a very useful piece of knowledge in countries where the meteorological stations are few and far between, such as Asia and America.

The constitution of climatic zones should not be based on herbaceous plants, even perennials, but on trees, and among trees those which have a limited *habitat*, for instance, spruce, beech, chestnut, lime. The Scotch pine, whose *habitat* extends from that of the chestnut south of the Alps to the Polar Circle, is useless as a character. (It would be interesting to compare the opinion of M. Mayr with the learned theories propounded by M. Flahaut in the *Revue* of 1901.)

3. Forest species may be grown in places far from their original *habitat*, provided that the local climate of the new region is analagous. If the exotic comes from a warmer climate, it should be placed on south slopes with plenty of sun; if it comes from a colder climate, it should be placed in moist soils and cool aspects. Climate opposes an insurmountable barrier to natural reproduction. There is no such thing as acclimatisation. If certain species like walnut and robinia have been naturalised for centuries, it is simply because the climate of naturalisation was essentially like that of origin. There is no adaptation to a new and different climate.*

4. Trees of cold climates do not possess in themselves any special power of resistance to frost, and the immunity which seems to be sometimes possessed is an individual and non-transmissible quality. It is thus useless to import seed from colder climates in the hope of obtaining greater hardiness.

5. Trees growing in hot localities or in open crops are less exacting in the matter of soil. They are more exacting in cold moist localities or in the crowded state. The conditions of heat and light are similarly related. All species bear shade better when brought to a warmer climate, and require more light when brought to a cooler one. Trees which bear a certain amount of cover in their optimum climate (ash, maple, elm, Weymouth pine) become shade bearers in hotter climates and cannot endure shade in colder ones.

* But trees brought, for instance, from the southern to the northern hemisphere will accommodate themselves so far as to flower say in June in India when their natural season may have been December in Australia.—TRANSL.

6. In level countries where the heights do not exceed 100 or 200 metres above sea-level, the *habitats* depend on latitude, modified very considerably by winds from the sea; thus in the west of Northern and Central Europe they follow rather longitudes than latitudes. In high mountain regions, altitude may produce effects similar to those of latitude. The climate of the northern plains is found in the south at some elevation above sea-level, so that a species has often two *habitats*, a northern and a southern. It is therefore a mistake to label one species as a mountain species and another as a plains species. The spruce in Europe, the Douglas pine in America are mountain species in the south and plains species in the north.*

7. The climatic needs of a species are better characterised by its *habitat* than by the latitude or altitude at which it grows. Latitude and altitude combined furnish a more reliable but still insufficient basis. If you tell a forester that the European larch grows at 1500 metres altitude on the 46th parallel of north latitude, or that the Japanese larch flourishes at 2000 metres on the 38th parallel, he gets no clear idea. But if told that both larches prosper in the region of the fir and spruce he grasps it at once. Perhaps a certain reserve is here necessary; few foresters will agree that the larch has the same *habitat* as the fir and spruce.

8. If, in a given climatic zone, there are found two neighbouring species of the same genus, such for instance as *Quercus pedunculata* and *sessiliflora*, it may be predicated that these two species were not originally amalgamated, but each had its distinct *habitat*, and that the mixture is generally due to the action of man. In Japan and America, where the flora is much richer, the applications of this law are far more striking. In practice, too, little attention is paid to these divergent exigences of climate, for though slight they are of great importance.

9. In primitive forests the species which harmonise best are those which differ most botanically, though requiring the same climate. (Beech and fir, oak and pine, maple, ash and lime.)

10. When two species are so alike as to be considered almost varieties, but have nevertheless different climatic needs, they are in reality true and distinct species. It is an error to consider morphological differences as a result of climate, and to say, for instance, that the Russian spruce (*Picea obovata*) is only a form of the German spruce modified by severity of its locality. If this were so the Russian spruce would be found on the tops of the mountains, but we know that there is nothing of the sort.

* True for many species, but is not barometric pressure a condition affecting plants?—TRANSL.

M. Mayr will perhaps permit a note of interrogation here. It appears from certain studies made in France, notably by MM. Brenot and Mathey, that *P. obovata* exists both in the Alps and in the Jura.

11. Frost-injury is always due to the death of the plasma killed by the direct action of cold. The plasma is most sensitive during the time of cell-formation and active growth. When the functions of life appear dormant the chlorophyll is more sensitive than the colourless plasma. This explains the disease called "*le rouge*," which is due to sun and cold combined killing the chlorophyll. Plasma in the inert stage, as in seeds, is insensible to the intensest cold.

12. All species become more hardy as they grow older, but this is not a phenomenon of adaptability. The fact is simply due to the trees rising above the cold layers of temperature near the ground, and to the greater thickness and mass of the trunk.

13. The degree of moisture in the air is a great factor in forest vegetation. Experiments made in North America convinced M. Mayr that the forest ceases to exist in regions where the tension of water vapour averages less than 0·50 during the four months of growth: here is the domain of the steppe. Oaks and 2—3-leaved pines are the pioneers of the steppe; it is they which least fear the neighbourhood of the dry zone. As this zone is left further behind, the number of species increases, but it is only on approaching a moist zone that the firs, spruces, cypresses, and 5-leaved pines appear. Hence the broad-leaved trees and 2—3-leaved pines are the only suitable species where the air is very dry, or where its moisture is subject to sudden variations.

14. The association of trees as a crop has the effect of raising to some extent (10 per cent. at most) the degree of atmospheric moisture. This emphasises the need for maintaining forests in regions where the water-vapour tension varies round 0·50 per cent. The partial destruction of a forest may entrain the death of the remainder, and render *reboisement* impossible except adjoining existing forests. Inside a forest the greater humidity of the air has an action as beneficent as that of the moist ocean winds, and is exempt from their violence.

15. It is in moist cool localities (mountain and northern) that climatic variations are least extreme during the growing season. It is there that the annual rings are all equal and the grain fine and regular. It is there that wood attains its maximum of industrial utility (resonance to sounds).

16. The moister the climate, the easier becomes forest culture; regeneration fellings, thinnings, etc., all are simplified.

Air-moisture seems to exercise a favourable influence on the straightness of stems in all trees, and especially in Scotch pine. It would be interesting to verify the fact in France.

17. It is known that a failure of rain for several days may be fatal to young plants. The faculty of persistence increases with age, and the grown tree can endure fairly prolonged periods of drought without much harm. But if the phenomenon recurs so that the mean rainfall of the four months growing season falls below 50 millimetres (two inches) the true forest disappears even if the air-moisture remains always above 50 per cent. Exception must be made in cases where the winter rains are very heavy and in the neighbourhoods of lakes and rivers with their sub-soil percolation.

18. A fairly moist soil is the best for all species when in their true climate. In hotter places, the locality must be more damp, while in colder ones it may be dry without hindering growth.

19. Snow protects those parts of a plant which it covers, but it increases the danger of frost in the parts just above, for there the cold becomes excessive. Snowy winters are, therefore, useful to low plants, but harmful to trees.

20. As regards winds, the most dangerous are those which follow the direction of barometric minima,—in Europe from the west, in Eastern America from the east,—in Eastern Asia from the south. Those coming from the opposite direction are less dangerous, but still more so than those coming from other points. Every elevation, mountain or hill, determines a deflection of the current, a vertical whirlwind as high as the obstacle, and a return in one of the opposite directions. In localities called sheltered the most dangerous wind for Europe is thus from the east, and consequently the rules for laying out coupes may require some modification. On the east slopes of a plateau, the regeneration fellings should be laid out north-east and south-west.

21. In their youth trees are almost indifferent to the quality of the soil, but with age their exigences become manifest. This explains the arrested development of many very promising plantations (larch on sand for instance).

22. In their most suitable situation all species are so to speak polyphagous, that is to say, they succeed on soil of any mineral formation; but as the locality becomes less favourable their exigences increase, so that certain exotics will only grow in parks or even in pots. This point is contestable, and it is doubtful if the chestnut would prosper on limestone in the best possible locality on the south side of the Alps.

23. The light that most favours the activity of the chlorophyll, and consequently the growth of trees, is not that of a blazing sun in a cloudless sky, neither is it the diffused light coming through rain or fog; but that reflected by brilliant white clouds. This shows what differences there may be in the effect of shade. Cover is favourable when it filters the rays of a too burning sun; unfavourable when it cuts off too much of the necessary light. Under a Continental climate cloudless days are more numerous than near the coast, light and heat are more intense; the influence of cover, of lateral shelter, and the effect of thinnings *will thus differ with the Continental* position. Forest operations need to be conducted not alone with regard to the soil and species, but also in accordance with the climate, aspect, and degree of sunlight. Here, again, sylviculture does not rest on arbitrary rules, but on the laws of nature. Under a more or less foggy *maritime climate, young trees do not require cover; the* mist and clouds suffice; the underwood is also unnecessary. The maritime climate is not limited to the sea coast; it is found also in certain mountain regions and notably round great lakes.

24. A knowledge of the laws of nature is especially necessary *in the regeneration of forest crops. Those which are approaching* their exploitable age in their most suitable climate are the easiest. If the climate is warmer, seed will indeed be more abundant, and the young plants will endure cover better, but the moisture of the air and soil may be wanting, and the necessity of maintaining a denser cover over them may intercept too much of the needful rainfall. If the climate is colder, the moisture of the air indeed increases, but the production of seed and the persistence under cover both diminish.

25. In mixed crops artificial regeneration is more difficult than natural regeneration. The clean felling induces a capricious complication of laws and phenomena whose contrary actions are not easily understood. Certain mixtures, such as spruce and larch, beech and larch, oak and beech, seem to require a mixed method, natural regeneration aided by artificial.

. . . . . .

The principles of M. Mayr are open to discussion, but few in France will controvert his conclusion, which is this:

"Natural regeneration, a mixture of species suitable to each locality, a crop resembling as closely as possible the primitive state, *such are the conditions which the forester should seek to* realise, not only for the avoidance of dangers, but also for the greatest possible yield of the most valuable produce." And he adds:

"The more one seeks to build up sylviculture on rational bases, *the more one becomes convinced that there is no method*

of treatment which harmonises better with the laws of nature than the method of *jardinage* (selection method). Not the primitive *jardinage*, which was merely a harvesting of the ripe trees, but that regulated *jardinage* which, in a forest containing the greatest possible variety of species and age classes, removes no single tree without aiming definitely towards either the regeneration or the improvement of the crop. Irregular *jardinage* is the most ancient, the easiest, and the roughest mode of treatment. Regular *jardinage*, with the view of placing each tree in the conditions most favourable to its development, is the most perfect and the most difficult of treatments. It is an ideal not always easy to realise."

For our part, we can only endorse this conclusion, which seems to be the coming idea. Standards over coppice and selection forest have many points of contact, and there are already many foresters who hesitate to destroy a crop on pretext of regenerating it. Is it not possible to conceive a treatment which, given a duly constituted forest, should maintain it always and for all time in the same condition? Why should not the XXth Century realise this "*Unity of Sylviculture*"?

The Insect World in an Indian Forest and how to study It.

By E. P. Stebbing, F.L.S., F.E.S.

(*Continued from p.* 111.)

Part VI.

The Order *LEPIDOPTERA*.

This order comprises the butterflies and moths, both of which are very numerous in India. They are provided usually with four wings, all of which, together with the body, are covered with coloured scales, those on the body looking more or less like hair. The mouth parts in the perfect insect are formed for sucking, and are in the form of a coiled tube or proboscis. This proboscis is the characteristic feature of the mouth of a lepidopterous insect, and owing to the possession of such a mouth the destructive powers of the adult are very limited. The head is small, with two large eyes, and ocelli may be present. The antennæ are simple and knobbed or pectinate. The prothorax is small, flat and scale-like, and is attached to the other portions of the thorax. The wings are various in shape, and the hind wing is sometimes prolonged into a tail. The wing is divided for purposes of description into the following regions: inner angle, costa, outer angle, hind margin, anal angle and inner margin. The wings are always fringed with hairs. The legs are unusually long, slender and weak, the tibiæ being furnished with spines. In most moths the upper and lower wing is joined by a hook-and-loop arrangement, the loop being on the upper

and the hook on the lower wing. This is never present in butterflies. Tarsi are five-jointed. The abdomen is cylindrical and sometimes flattened on each side. The males differ from the females in being smaller, more brightly-coloured, with a thinner body, more highly developed antennæ, and by having the body sometimes terminated in a clasping arrangement for catching hold of the female. The eggs are various in shape and are often very elaborately marked. Practically the only damage done by this Order is committed in the larval state. The larva has a cylindrical worm-like appearance. It consists of a well-marked head followed by twelve segments. The first three segments bear legs which are jointed and horny, and are called thoracic legs; next there are two small segments with no legs, and then four segments bearing each a pair of sucker-like legs provided with small hooks for clinging to leaves, etc. These legs are called the abdominal legs. Following these there are two more legless segments, and the last segment bears a pair of clasping legs. Never more than eight pairs of legs are present in *Lepidoptera*, though the number may be fewer, and in this way caterpillars can always be distinguished from saw-fly larvæ (*Tenthredinidæ*), which greatly resemble them, the latter having always more than five pairs of clasping legs. In some caterpillars only the thoracic legs and the last pair of abdominal and clasping legs (also called pro-legs) are present. In a few cases the pair of clasping legs is absent. The head is provided with a few ocelli placed just above the mouth. The antennæ are short and three-jointed. The larva is sometimes provide with silk, and there are then two small glands at the sides of the body, the silk coming from these as two separate threads, which become glued together by a cement that hardens in the air; the larvæ suspend themselves by this thread. There are nine pairs of spiracles (breathing openings) present, situated at the sides of the 2nd, 5th, 6th, 7th, 8th, 9th, 10th and 11th segments. The anus is covered by a triangular flap. The larva is covered with hairs which may be few and small or long and numerous; these spring from tubercles situated on the grub. Whilst developing the caterpillar passes through a series of moults, 2—5 in number, but usually four, during which it may change considerably both in form and colour.

The larva pupates either by burying itself in the ground, hanging itself up by its tail, making a silken cocoon (external covering) and changing to a chrysalis within this, rolling up the edge of a leaf and pupating inside, etc. The pupa is covered by a continuous skin, which only shows the outline of the limbs of the future insect and the division of the abdomen below; projections indicating eyes and proboscis are also visible. The proboscis may project a long way in some cases, as in the Hawk Moths. When the insect is mature it bursts the skin and crawls out. The wings at this stage are very small and soft and crumpled up. After leaving the pupal skin the perfect insect hangs itself up, head

uppermost, and pumps fluids from its body into the wings so as to expand them. This process never takes more than two hours; by the end of which period the wings are fully expanded and hardened and are ready to be used for flight.

The length of the whole life-history of Insects of this Order may vary from two weeks or less to over four years. In the latter case the greater part of the time is passed in the larval or destructive period of their life. Little is at present known about the wood-boring members of the Order in India, and their study is becoming an important matter. Mimicry and protective resemblance is very marked amongst the *Lepidoptera*, and cases are numerous where a harmless insect assumes the colouration and markings of a noxious one to escape the attacks of its bird and insect foes. For instance members of the genus *Papilio* often mimic the colouration of the noxious *Danaids*.

The *Lepidoptera* are divided into the two series, *Rhopalocera* or butterflies and *Heterocera* or moths.

Series Rhopalocera or Butterflies.—Antennæ knobbed at the tip or thickened a little before the tip, without pectinations or projecting processes. Hind wings without a frenulum (the one or more stiff bristles projecting forwards and outwards from the inner upper angle of the hind wing are called the frenulum) but with the costal nervure strongly curved. The insects are diurnal in habits. Larva has always 16 legs.

Series Heterocera or Moths.—Antennæ vary in form, generally pectinate, only rarely knobbed at tips, and then a frenulum is present, and the costal nervure is either not arched at the base or there is a large margin between it and the front margin.

RHOPALOCERA—(Butterflies)

Are of little importance in forestry as far as is at present known. They may be divided into the following four groups:—

I—Includes the majority of butterflies. The first pair of legs are strikingly modified, they being generally smaller than the others and not used for walking; the tarsus often does not consist of a succession of simple joints, as is usually the case with insects. There is no pad on the front tibia. The chrysalis is naked and suspended by its tail to the food plant, or is girt round the centre with a silken cord. The families included in this group are the *Nymphalidæ* [to which the leaf-butterfly (*Kallima*) belongs], *Erycinidæ*, and *Lycœnidæ* (to which the Blues and Coppers belong).

II.—The front legs are similar in form to the others; their tibiæ have no pads; the claws of all the feet are bifid. The pupa is attached to the food plant by a silken cord girt round about its centre. The group includes the *Pieridæ*, containing the Whites, Brimstones, Clouded Yellows, etc.

III.—The front legs are like the other pairs; their tibiæ, however, possess pads; the claws are large and not bifid. The pupa is naked and tied to the food plant by means of a silken cord round it. The family *Papilionidæ*, consisting of the swallow-tail butterflies, comes here.

IV.—The front legs are like the other pairs, their tibiæ possess pads; the claws are small, toothed at the base, and there is a hook at the end of the club of the antennæ. The chrysalis is rolled up in a leaf or other covering. The family *Hesperidæ* or skippers are included here. Mr. P. Mackinnon, a well-known Indian authority on the *Rhopalocera*, has informed me that he has bred these insects from various fruits in India, and it is now, I think, becoming more than probable that the family will be found to contain many species harmful to orchards, to crops and vegetables, and perhaps to trees in the forest as well. Mr. Mackinnon has promised to continue his interesting and important economic investigations into the habits of these pests.

HETEROCERA—(Moths).

The series *Heterocera* or Moths is a most important one in forestry. Next perhaps to the great Order *Coleoptera*, the moths contain some of the most dangerous pests the forester has to deal with. Both as defoliators, wood-borers, shoot miners and seed destroyers these insects are to be found at work in the forest, and the destruction caused is sometimes on a very large scale. For our purpose we shall consider the series as comprising fourteen families, and these will be dealt with below in such detail as seems to be required.

FAMILY BOMBYCIDÆ (TRUE SILK-WORM MOTHS).

Largish moths with stout woolly bodies, with no proboscis and no frenulum to the wings. Antennæ are short and are feathered in the male. The larvæ are hairy and are gregarious. The pupa is formed within a silken cocoon, the silk of which has often a commercial value.

There are several important species in the family. The domesticated mulberry and *eri* silk-worms and the semi-domesticated *tusser* and *muga* silk-worms are worthy of note. In addition there are a number of wild silk-worms in India whose silk is very good and would be extremely valuable were it forthcoming in larger quantities.* Several varieties of the mulberry silk-worm, *Bombyx*

*In 1895 and again in the following year the writer, whilst holding charge of the Tista division, offered a prize at the annual Kalimpong *mela* (held towards the end of the year at Kalimpong in British Sikkim in the eastern Himalayas) for the best exhibit of silk from some of the wild silk-worms from that part of the world. The conditions were that all stages of the life-history of the insect were to be shown, together with specimens of the reeled silk, the apparatus used to reel it and specimens of materials made from it. Some exceedingly interesting exhibits were sent in, especially in the second year, and the writer has little doubt that could a good cross be obtained with some of these Sikkim silk moths a most valuable silk would result.

mori, are cultivated in the plains of Bengal upon mulberry leaves, and a large amount of valuable silk is obtained from them annually.

The insect suffers considerably from Tachnid fly and other parasites. The *Eri* silk-worm, *Attacus ricini*, is reared in Assam on castor oil leaves. It has several generations in the year (as also has *B. mori* in India), and the silk produced is the well-known coarse Assam silk. In the forest the most important silk-worms are the *Tusser* and *Muga*.

The larva of the *Tusser* (*Antheræa mylitta* and *A. paphia*) is a brilliant green adorned with numerous tubercles. The moth is a large yellow or buff coloured insect, which can be recognised by its shape, size, and the curious transparent glass window-like patches in its wings. The cocoon is large, hard, and is attached to the food plant by a silken stalk of great strength. This insect is reared in the forests of the Central Provinces, Chota Nagpur, and elsewhere throughout the central and southern parts of India. The caterpillars feed upon the leaves of *Terminalia tomentosa*, sal, *Zizyphus Jujuba*. etc. The insect hibernates through the winter in the cocoon. The moths of the first generation emerge in the beginning of the rains (June) and lay eggs from which cocoons are obtained about the middle of the wet season. Moths are obtained from these and lay eggs immediately. From the eggs so laid cocoons are formed about the beginning of the cold weather (October, November). Fresh cocoons for breeding are generally collected each March in the forest when the foliage is thin and they can be easily discerned. These are tied on to the trees, the latter being pollarded.

The *Muga* (*Antheræa assama*) is reared in Assam in much the same way as the Tusser in Chota Nagpur as above described. The cocoon has no stalk, and the silk has a beautiful golden sheen. The insect is reared upon *Machilus odoratissima*, *Tetranthera monopetala*, etc.

Forest revenue is obtained in various parts of India from these insects, and it is not at all improbable that, if the experiment were carefully conducted, their introduction might be possible into poor areas of forest growth in parts of the country where they are are not at present found.

FAMILY EUPTEROTIDÆ.

The wings in this family possess a frenulum, the larvæ are hairy and these hairs often produce great irritation to the skin. The caterpillars are sometimes social in their habits, and live together in dense webs on trees and plants or march about in processions, when they are called 'processionary caterpillars.' Those living in dense webs on the other hand are called 'tent caterpillars.' Processionary caterpillars are not uncommon in India. Two instances of the annoyance they cause may be mentioned. In 1891 a plague of hairy caterpillars appeared in

Shwebo, Burma, and covered the country, eating all herbage and swarming on roads and in buildings in enormous numbers; their hairs produced irritation and even sores on the skin. In September 1901, another of these processional caterpillars swarmed in the station of Seoni in the Central Provinces, appearing in millions and invading gardens and houses, stables, cook-houses, choking up drains, etc.

It follows that the members of this family are dangerous not only owing to the actual defoliation damage they are capable of doing, but also to the fact that when they swarm, they become a veritable plague to man, bad sores resulting from the irritating properties of the hairs. Their dead bodies choke up drains, etc., giving rise to noxious effluvias, which are liable to produce pestilence, and in this way they resemble that scourge the North-West locust.

FAMILY SPHINGIDÆ (HAWK MOTHS).

Moths of large or moderate size, with frequently a very long proboscis, and provided with a frenulum on the long narrow wings; bodies stout and often torpedo-shaped. Antennæ are short and stiff, ending in a hook at the tip. The larva is large and fleshy and generally remarkably coloured and is provided with a horn on the dorsal surface of the eleventh segment, and has sixteen legs. The caterpillars do not spin cocoons, but bury themselves in the earth. In the pupa the proboscis sometimes projects on the breast like the handle of a pitcher. The larvæ feed upon vegetation. A species named *Pseudosphinx discistriga* defoliates the teak in the Melghat forest in Berar. It is bright green in colour, changing to dark yellow-green on maturing. In July, 1901, it was in considerable numbers on the trees, and a fairly large amount of defoliation had been occasioned by it. The same larva was also found in the Central Nursery at Poona, and it may prove to be general throughout the Bombay and Central India teak forests. The moth issues about the beginning of August, and the pupal stage is probably a short one.* The rest of the life-history has not yet been worked out, but the case is an interesting one, since hawk moth larvæ are not usually to be found feeding gregariously together.

FAMILY SESSIIDÆ OR ÆGERIIDÆ (CLEAR-WINGS).

A comparatively small family of moths, whose wings are without scales; the tip of the body is tufted, and the insects resemble wasps to a great extent. The larva is nearly naked and colourless, and thus resembles a longicorn grub. It can be distinguished, however, by the fact of its having 16 legs. The larvæ feed in wood and do damage to trees in this way. They invariably feed concealed in stems, branches, etc. The pupa is

* For further information on this insect *vide* Departmental Notes on Insects that affect Forestry, No. I., p. 52, Pl. II, fig. 1.

furnished with a row of spines on the segments of the abdomen. The Baluchistan poplar borer, *Trochilium omnatiæforme* is a larva belonging to this family. The eggs are probably laid in the bark of the tree attacked during October and November, the larvæ hatching out either immediately or more probably in the ensuing spring. As soon as hatched they bore through the bark. In April, when about half-grown, they may be found between the bark and the wood. From this time they commence boring straight into the heartwood and remain tunnelling in this until September. The larva changes into a pupa inside a cocoon formed of wood chips placed near the entrance of its burrow.* The adult insect appears in October. It greatly resembles in appearance the small Indian wasp, *Vespa cincta*. *In 1890, the poplar trees (? Populus euphratica)* suffered severely in Baluchistan from this insect. The trees were grown from cuttings, and when about two years old they were attacked by the larvæ. The eggs must have been laid on the bark near the ground, and the caterpillars on hatching out bored through the trunk and riddled the wood in all directions, the stems being generally killed off before they reached the age of five years. The roots were not attacked, and therefrom fresh shoots came up in the majority of cases, the loss experienced being the putting back of the plantation by several years.

FAMILY PSYCHIDÆ (BAGWORMS).

Small or moderate-sized moths, with imperfect scales and dusky in colour. The sexes are very different, the female being wingless and sometimes quite maggot-like; the male often has bipectinate antennæ, the branches of which are sometimes very long and flexible. The larva soon after hatching forms for itself a case of pieces of stick, leaves, etc., in which it lives, carrying it about on its back, like a snail its shell. This case is always present, and the wingless female moth never leaves it. The larvæ do damage as defoliators.

A species of this family, *Clania variegata*, has been reported as defoliating the sal tree in the Duars in Bengal. The female lays her eggs about the beginning of March, within the pupal shell inside the case. After laying these eggs, her abdomen becomes much reduced in size and she drops out of the case and dies. The eggs are smooth yellow ovals, from which larvæ hatch out at the beginning of April. This is the first brood of the year, and several others follow it through the hot weather and rains. Three to four days after hatching out the young larvæ begin to construct their cases with pieces of moss and bark of sal trees, etc., and they feed upon the young new sal leaves. The mouth of the case is made flexible so that the larva can draw in its head for protective purposes. As it grows older the larva feeds upon the older leaves of the tree. When about to

* For a further account *vide Injurious Insects*, pp. 95-98. Figs. 62, 63, 64.

change to the pupal state the case is fastened to a twig or to the bark and the mouth of the case is then closed. The larva then proceeds to cover the inside of the case with a fine loose silk, and turning round hangs head downwards inside and changes to a pupa In emerging the male cuts its way out of the cocoon by means of its sharp edged beak, a portion of the empty pupal skin being often seen projecting from the case. It has highly pectinated antennæ, and is about two and-a-half inches across the wings. The female has some means of attracting the male to her, and pairing takes place by the male inserting the end of his abdomen down into the case, which the female, being as mentioned above practically wingless, never leaves.

The larvæ of another member of the family, *Clania crameri.* feed upon the needles of the *Pinus longifolia* in the N.-W. Himalayas. The caterpillars hatch out in July and at once commence to feed upon the needles of the pine, from which, together with twigs, they construct their cases. They remain feeding upon the trees until November. The winter is passed either in the larval or semi-pupal state. Perfect pupæ are to be found within the cases in April of the year succeeding that in which the defoliation took place. The moth appears in June. † This insect occasionally does a great deal of damage (markedly so in 1898) to the P. *longifolia* by entirely stripping the trees of all their needles, in which state it is not improbable that the trees will be attacked by the *Polygraphus longifolia*, MS., and *Cryphalus* ‡ bark-borers which infest this tree (*vide p.* 108 *ante*).

As the larvæ of this family usually form their cases of dried twigs, moss, grass, straw, leaves, etc., they are generally very difficult to see when amidst their natural surroundings, and it is probably due to this that at present so few species have been reported as doing damage in the forest. Many species are known to feed entirely upon the leaves of woody growths (trees or shrubs), and the cases constructed are remarkable for their ingenuity and variety. A study of the family should well repay those who take it up.

Navigability of the Garonne.

MANY readers of the *Indian Forester* may be unaware that the most important river of the south of France, the Garonne, used to be navigable for considerable ships, and no longer is so. In addition, the river has become a standing menace to life and property, and a sink-hole that swallows gold like water, all through the

* *Vide Injurious Insects*, pp. 98 - 101 and Fig. 65.

† *Vide* Departmental Notes on Insects that affect Forestry, No. 1, pp. 56-57 and Plate II, Fig. 2, a b,c.

‡ *Vide* Departmental Notes on Insects that affect Forestry, No. 2. pp. 255--257, 267 -273.

enjoyment of forest rights by the mountain population, and for no other reason whatever. There is an important society, calling itself "La Garonne Navigable," the object of which is expressed in its name, *viz.*, to work for the navigability of the Garonne. Before this society two important papers were recently read by MM. Favre and Buffault, the gist of which I have boiled down from the *Revue des Eaux et Forêts* for 15th July 1902.

M. Favre commences by pointing out that the forest is nature's own chosen weapon in both struggles, *viz.*, the struggle *for* water, and the fight *against* water. In the absence of forest there is still the perennial vegetation on the soil which can be turned to good account. "The forest is the sovereign governor of the water supply"—(E. Risler). The "torrential" characters now acquired by the Garonne are costing many human lives, and in addition about eight million francs annually, including three millions for dredging alone. The hydrographers say that the silting-up is frightful. None of the forest works in the upper valleys take any note of navigation. Their object is purely local, being the protection of the threatened localities in the Pyrenean mountains. No law touches the primary cause of erosion of the "'torrential" character of the mud-transport, namely *the surface flow*. Its origin is not always confined to the actual sources of the rivers themselves, but extends to other parts of their basin. The question is not a purely geological one, but is greatly affected by the action of the great Pyrenean screen which condenses rain from the ocean winds.

Agricultural irrigation has greatly increased, and now greatly affects the Pyrenean river supply, with the result that the low-water flow is diminished to the great injury of manufacturers and sailors, whilst the floods are worse than ever. The destruction of the turf, and especially of the woods, is visibly increasing; its progress is evident from the statistics of the dangerous zones of the basin.

The cause is to be found in the difficulties surrounding the application of forest regulations and in the unrestrained enjoyment of common rights in the mountains. The proposed measures of defence are the following :—

(1) An understanding with a view to joint action over the whole of the forest and pastoral regions round the sources of the Garonne and Loire.

(2) The appointment of a technical commission to elaborate a programme for the localisation of the evil, and for its treatment through the agency of the Forest Department.

(3) The application, to the forests, of measures calculated to preserve the wooded condition; and to the pasture, of steps to restrain the enjoyment thereof so far as may be needful to preserve pastoral conditions.

M. Buffault's paper had reference to the insufficiency of forest legislation for the purpose, and the difference between French and Indian laws renders it useless to go into details, but he, too, laid stress on the great progress of denudation, and on the need for subjecting all communal lands to strict management by the Forest Department. He showed how the common-holders formed so called syndicates, and used them as an agency of destruction. After some remarks in support by M. de la Bruyere, Councillor of the Rhone, the society adopted the conclusions.

To apply this lesson to India is a somewhat delicate task, which each forester may do for himself. In France the forest administration is autonomous. There is a Minister of Agriculture, a professed politician, but generally sympathetic and keen. After him comes the Director-General of Forests (and Waters) a trained forester, to whom alone the conservators, etc., are responsible. In France the enemies of forests are mostly interested right-holders, and that only in certain regions. In India we have right-holders and endless privilege-holders, who are as bad, together with others, who ought to know better but do not. The latter have sometimes done their best to fix for all time the most harmful practices, and have even crushed the professional staff under repressive and penal legislation. The question of autonomy stands in the way. It is a necessity, and it is perfectly feasible, but stands little chance of adoption at present. The State forest domain is of equal importance with the State public works, though the current revenue will not bear comparison. Yet the latter have great secretariats in each branch, while the former is muddled by the local caprice of all kinds of uninstructed, prejudiced, incompetent persons, down to the tehsildar. Even if a bad forest policy is a temporary necessity, it could be run by a Forest Secretariat better than at present, and the reins would be much nearer to the hand of Government.

F. G.

Lac in Guzerat and the Konkan.

GUZERAT.

WHEN on famine duty in the Panch Mahals district in 1899 I collected, during my wanderings, the following information about lac produced in the forests and waste lands of the district and in the congeries of Native States bordering on it, which form what is known, I believe, as the Rewa Kanta, and it seems to me that it may be interesting to have this information recorded rather than permit it to be buried in oblivion. It is observed that in the recent valuable note in the *Agricultural Ledger* drawn up by Sir George Watt, Reporter on Economic Products, information about lac in Guzerat is confined mainly to a description of the lac industry in the Panch Mahals, which may render the present brief data about quantity, etc., of lac available all the more necessary.

It is estimated by merchants that the following quantities of lac are annually collected and exported from the places named below to other parts of India:—

Panch Mahals District.

	Mds. (of 80 lbs.)
British Territory	300 to 500
Lonewada State	1000
Deogud Baria State	4000
Chota Udepur „	4000
Ali Rajpoor State	not known

In order to verify these figures information on the subject was sought from the Political Agent, Rewa Kanta, Mr. Carmichael, I.C.S., and he has very courteously supplied me with details about the export of lac from the different Native States surrounding the Panch, Mahals, as follows:—

Deogud Baria State.—621 maunds of 40 seers average amount exported annually during past seven years.

Chota Udepur State.—Average of five years 1168 maunds of 40 seers.

Lonewada State.—Nil.

All these Native States permit their subjects to collect lac from the forests and waste lands free of charge, levying merely a duty on the amount exported.

The vast discrepancy between the figures supplied by contractors and those of the Political Agent seems to need explanation, which I am not in a position to give.

It is proverbial how much the native is addicted to exaggeration, and the figures supplied by merchants on the spot may in consequence be very inaccurate; but room for suspicion seems to exist that the native administrations are not obtaining all the revenue they are legitimately entitled to from their exports of lac.

The Political Agent states that during the past five years, up to 1900-1901, the export duty on lac from Chota Udepur amounted to Rs. 2533 or about Rs. 506 per annum, and from the Deogud Baria State to Rs. 310 per annum for the past seven years.

No other State appears to derive any revenue at all from lac.

The produce is gathered in the forests chiefly from the following trees :—

Kakra.—*Butea frondosa*, abundantly.
Bhor.—*Zizyphus Jujuba*, also abundantly.
Ghat Bhor.—*Zizyphus nummularia*.
Pipul.—*Ficus bengalensis*.
Sadar *or* Ain.—*Terminalia tomentosa*.
Pasi.—*Dalbergia paniculata*.
Kala Sirus.—*Albizzia odoratissima*.
Koshimb.—*Schleichera trijuga*.

There are two crops: one gathered in May-June and the other in November; the former being considered the better on account of the larger number of insects.

Naikdas and Bhils mainly are engaged in collecting them. An adult gathers about four to five seers of lac per diem, and the price paid for the produce by petty contractors is one anna per seer. As the trees on which the lac is found are not gregarious, collection is somewhat troublesome. In private areas the produce is sold from two annas to four annas per tree to contractors.

In the Godhra taluka of the Panch Mahals district, centres or depôts exist where lac is brought by the wild tribes to petty contractors from the neighbouring Native States as follows :—Shera, Nadurho, Ratanpur and Mora; at the two latter places the collections are comparatively large, as they are situated close to the borders of the Native States. A certain quantity of lac is also collected from the Panch Mahals forests, but the quantity apparently is not large enough to be noticeable. The petty contractors remove their produce to Godhra, where it is purchased by large wholesale lac merchants, who export it to various parts of India.

One contractor stated that the price of lac in Godhra in a favourable year is Rs.16 to Rs 18 per maund of 80lbs; that the price in 1899, during the famine, fell to Rs.4 per maund, and that in 1897-1898 it was Rs.7.

These figures correspond mainly with those given in the Panch Mahals *Gazetteer*.

In the latter work it is shown that quite a large industry exists among the Bhils in the eastern parts of the district in the manufacture of bangles and other ornaments made from lac.

*Konkan.**

With the exception of the lac found by Dr. Carter inside the grounds of the old Bombay Mint in 1860, no record exists apparently of it having been discovered elsewhere in the Konkan. In 1899 I noticed pipul trees (*Ficus religiosa*) on the maidan in Thana and khair trees in some of the forests in the Bassein taluka of the same district bearing lac; but the incrustation on the trees was sparse. Close to Bassein, which is on the sea-coast, roadside trees of *Pongamia glabra* have also been found bearing lac.

The rainfall, it may be mentioned, in the Thana district averages about 90 inches, and the soil is laterite, *i.e.*, decomposition of trap. The thermometer in the hot weather rises above 110.

In the Panch Mahals and surrounding Native States the rainfall varies between 25 and 40 inches.

THANA DISTRICT:
14th January 1903.

G. M. RYAN.

British Forestry.

THE report of the Departmental Committee appointed last February see *Journal*, vol.I., p. 428) to inquire into the present position and future prospects of forestry has been published as a Parliamentary paper. The present Departmental Committee endorse the conclusions of the Select Committee of 1885-87 as regards the neglected condition of forestry in Great Britain, the possibility of improvement, and the necessity for the provision of better means of education. As regards the question of the extension of the forest area, the committee point out that there is on the highest authority in these islands an area of waste, heather, and rough pasture, or land out of cultivation, amounting to 21,000,000 acres, on a large proportion of which afforestation could be profitably undertaken. The committee believe that the importance of afforestation in such a district as the Highlands of Scotland will be readily grasped. The area of waste land which might be afforested becomes a matter of grave national concern, when it is remembered that according to exports, the world is rapidly approaching a shortage of, if not actual dearth in, its supply of coniferous timber, which constitutes between 80 and 90 per cent. of the total British timber exports. The committee do not feel justified in urging the Government to embark forthwith upon any general scheme of State forests under present circumstances, but believe that the question of planting suitable waste lands under the control of the Crown, or over which the Crown exercises manorial rights, is worth the attention of the

* The Konkan is a tract of country below the Western Ghats, including mainly the districts of Thana, Kolaba and Ratnagiri.

Commissioners of Woods and Forests. Dealing with the question of education, the committee state that even where access may be had for purposes of instruction to private woods, it is exceedingly desirable that collegiate instruction in forestry should be illustrated by means of example plots, a total area of 100 to 200 acres at each educational centre being necessary and sufficient for this purpose.

The recommendations of the committee are:—

"(a) That two areas for practical demonstration be acquired, the one in England and the other in Scotland, of not less than 2000 acres, if possible, nor over 10,000 acres in each case. We suggest that the Alice Holt Woods in Hampshire be made available as soon as possible to serve as a demonstration area in *England; and that a suitable estate be purchased in Scotland*, as convenient as possible to Edinburgh, for the same purpose. These recommendations would have to be carried out by arrangement between the Commissioners of Woods and Forests and the Board of Agriculture; and assistance should be looked for from local authorities, societies, and individuals interested in forestry and technical education.

"(b) That additional facilities for instruction be afforded, by the appointment of a lecturer on forestry in connection with each of the Universities of Cambridge and Oxford, and that example plots be provided in connection with each of these centres and with Edinburgh.

"(c) That a good grounding in forestry form an integral part of the curriculum of the colleges providing instruction in agriculture in Great Britain; and that short courses of instruction suitable for the requirements of young foresters be provided there. Instructors should also be available for giving practical advice in connection with the management of woods, the owners of which desire an expert's opinion.

"(d) That provision be made for the education of foresters and woodmen by employing students to work in both the demonstration forests; and that suitable buildings be erected on the ground for the instruction, and, where necessary, for the accommodation of these student-foresters.

"(e) That lectures be given, under the auspices of the county councils, in neighbourhoods where there is a considerable area underwood: and that scholarships be offered in such counties to enable working foresters to attend courses of lectures.

"(f) That the inequality shown to exist in the levy of the state duty on timber be redressed.

"(g) That the Government be urged to secure the early enactment of a Bill to protect owners of woods against loss by fire caused by sparks from locomotives.

"(h) That the inquiry conducted in 1895, concerning the area of woodlands, be repeated by the Board of Agriculture, and that details concerning the character of the timber crop grown upon them be ascertained.

"(i) That the attention of corporations and municipalities be drawn to the desirability of planting with trees the catchment areas of their water supply."—*Journal of the Society of Arts.*

VII.—TIMBER AND PRODUCE TRADE.

Churchill and Sim's Wood Circular.

February 4th, 1903.

East Indian Teak.—The stock of timber in London continues to shrink and prices remain quite steady at the high level attained in December. There is no better prospect yet of fuller supplies, and it seems fairly certain that they must again be very restricted throughout the year. The deliveries in January were 567 loads, against 1053 loads in January 1902.

Rosewood, East India.—There has been enquiry for large good logs, small lots of which would realise fair prices, but of other descriptions the stock is ample.

Satinwood, East India.—There is now a fair stock on hand, the chief demand being for figury logs.

Ebony, East India.—Sizeable logs, if really good, would sell well, but for lower qualities there is less demand.

PRICE CURRENT.

Indian Teak, logs, per load	...	£10 10s. to £18 10s.
,, ,, planks ,,	...	£13 10s. to £20.
Rosewood per ton ...	...	£8 to £11
Satinwood, per s.ft. ...	...	6*d*. to 12*d*.
Ebony, per ton ...	...	£9 to £12

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Notes on a Tour through the Kheri Division, Oudh.

OWING to the presence of plague at Changa Manga, the senior classes of the Imperial Forest School were obliged this year to forego the usual tour to the Punjab, and were therefore able to spend a rather longer time in Kheri.

The following is compiled from notes made by the students of the School on a variety of subjects to which their attention was directed during the three weeks in January, 1903, spent in this interesting and instructive Division.

KISHANPUR FORESTS.

The first forests visited were in the Kishanpur Working Circle, Bhira Range, which are being worked under a provisional treatment of light improvement fellings on an eight year rotation, until the crop becomes sufficiently regular to allow of its being treated by the Selection method.

The present stock being very poor and consisting largely of small unsound trees, which, even when mature, can never yield good timber, it might perhaps have been better to work the forest under coppice-with-standards until it was fully stocked with sound well-grown trees.

The first cycle of fellings has just been completed, as the working-plan came into force eight years ago.

Although this forest has been protected from fire and grazing for 18 years, the crop still consists chiefly of old coppice shoots and of small badly-grown trees.

Even in Coupe I, felled over eight years ago, where there is a good amount of young growth, the crop is still so open that it

will not be expedient to continue the prescribed fellings for the next eight years, so it is proposed that this part of the forest be simply protected and left alone.

The young shoots of eight years old measured about one foot in girth and 25 feet in height.

Each coupe consists of about one thousand stocked acres.

The calculation of the possibility in the working-plan is based on an eye estimate of the stock, which has proved to be unreliable. It prescribes the removal of 107 sal stems of all size classes per acre; no lower limit of size is stated to define what is meant by a Vth class tree, of which about 22 stems are to be removed and 66 retained per acre at each operation.

This method of calculating the yield is unusual, but is only intended as a rough guide to prevent overcutting. The fellings should be made on purely cultural considerations without any number of trees being fixed.

In the actual working the fellings are made—as improvement fellings should be—strictly in accordance with sylvicultural requirements alone. In the coupe visited a complete enumeration of the stock left after the felling made over 157 acres, omitting all trees of less than three inches diameter, showed 52 II, III and IV class trees left per acre, instead of 41, as the estimate in the working-plan gives, and 56 Vth class trees, instead of 66.

The total of stems left per acre is therefore 108 (omitting trees of under 3″ diameter), which is practically the same as the number prescribed by the working-plan. There is hardly any miscellaneous species in this part of the forest, though the working-plan gives 55 as the number of stems of these species which are to be retained per acre in addition to the 107 sal trees.

The present workings produce principally fuel, and are sold at an average price of about nine rupees per acre. The selling price varies according to the distance of the coupe from the railway: at five miles distance the wood barely pays for the cost of extraction; at eight miles distance it has no market value. The railway rates for poles are so heavy that very few are exported by rail.

Firewood is stacked 5′ by 6′ by 20,′ or 600 cubic feet per stack; this corresponds to 300 cubic feet solid when the wood is half dry; and four stacked cubic feet go to the maund.

The forests of the Bhira Range are largely intersected by extensive grassy plains, which occupy more than one-fifth of the total forest area. These grassy plains are either *chandas*, which probably originated in old clearings made for cultivation, and are now often covered with a low growth of sal coppice shoots, which

are killed back perennially by frost, or else *phantas*, which are blanks, often low-lying, filled with coarse grass without any tree growth.

This present season has been a very dry one; the rainfall has been only 55 per cent. of the normal amount, and the frosts have been proportionately severe. The result is that not only have the ordinary yearling shoots been killed back, but also all taller shoots, which had succeeded during the last two or three years in raising themselves above the ordinary frost level.

These grassy blanks are gradually filling up, but the process is exceedingly slow and the area is vast. Signs are nearly everywhere apparent of a tendency of the surrounding forest to encroach on to these blanks.

Terminalia tomentosa generally advances into the *phantas*, and the sal follows as the ground becomes more drained and protected. There are some very encouraging islands of young sal reproduction around old sal trees on the edges of these blanks, and occasionally round isolated seed-bearing trees standing in the grass.

The improvement of these *chandas* is a very difficult matter. Frost and fire together have waged an unequal war against the sal, and in course of time it seems inevitable that the old stools must die and natural re-stocking become impossible.

Meanwhile perennial shoots are thrown up every summer from the old stumps, which are often shaped like hollow bowls with shoots growing up in a ring all round the edge, which shoots are year by year killed back by the frost.

The cost of artificially protecting these shoots from the frost by means of grass matting, etc., is prohibitive. Artificial standards have been tried of such species as *Odina*, *Spondias*, *Garuga*, but a nurse to be of any practical utility must be one of a hardy, light-loving and frost-resisting species, which retains its leaves late through the dry season. *Eugenia operculata* would be an excellent tree for this purpose: it is a hardy evergreen tree, with a broad, spreading crown through which sal saplings can easily push their way.

The second excursion from Mailani was to visit Coupe V of the Marha Coppice Working Circle. These forests are treated under the method of coppice-with-standards for the production of fuel; the standards being reserved to protect the underwood from frost as well as for the production of timber.

The difference of the effects of the frost inside and outside is very noticeable. In the open *chandas* every shoot is killed, but under the protection of the forest a few yards away not a leaf is withered, and in the allocation of coupes there is no necessity to take the danger of frost in consideration.

The railway takes nothing but sal wood as fuel, in billets of nine inches diameter and under.

The rotation of the coppice has accordingly been fixed at 24 years with a view to producing wood of this size.

About 55 standards are reserved per acre, and it has been hitherto the intention to keep them for three rotations only, till 72 years of age, as it was thought they would probably not remain sound long after acquiring 3½ feet in girth. It seems not improbable, however, that with improving conditions of growth, the sal would grow sound up to six feet girth and supply good timber. This part of the forest, Coupe V of the Marha Working Circle, is not as good as some parts of the trans-Sarda forests, Dudwa for example, but the growth is very good; the standards are rather close together, but the trees have small crowns, and the young growth is thick and very vigorous. The height of the leaf-canopy is about 70 feet.

The crop being practically composed of pure sal, with a varying admixture of *Terminalia tomentosa*, this forest might very well be selected for an experimental working circle, to be treated under the regular method with successive regeneration fellings.

The best parts of the forest are on the highest ground, and there is nothing to fear inside the forest from frost. Even this year, when the frosts have been exceptionally severe, not a leaf is touched in the forest, though everything in the open *chandas*, which intersect the forest, is killed. A protective belt of forest 50 feet broad is left round the *chandas*, and nothing is cut in it. The soil is a loamy sand. Measurements of sal coppice shoots of 4—5 years old showed an average of seven inches girth and 15 feet in height.

The working-plan originally prescribed that with a view to supplying data regarding the rate of growth every standard should be measured in every coupe.

It is an important part of every working-plan to prescribe the systematic observation and record of everything connected with the growth of the trees of the principal species, so that as time goes on, each working-plans officer may have more full and detailed data to go upon than his predecessor. It would be, however, neither necessary nor desirable to keep a record of the rate of growth of every standard reserved in the whole forest, so it has now been ordered instead, that a sample plot of one acre in extent shall be selected in every fourth coupe, and that all standards in it shall be measured every five years.

The students accordingly measured a new sample plot in Coupe V, containing 70 standards. Both girth and height of all trees were carefully measured.

Each tree bears a ring of white paint at a height of 4 feet 6 inches from the ground: it is, however, preferable to have the ring at a point where the stem is cylindrical and free from all irregularities of growth, rather than always to have it exactly to an inch at the proper height from the ground: in the case of trees with sloping stems too, the ring must be perpendicular to the axis of the tree, and not horizontal. The measuring tape must be held along the top edge of the paint mark.

Each annual coupe is divided into a number of plots, four or more, which are auctioned at a rate per acre to the contractors.

The work, however, is limited by the means of export, and as the railway has often been unable to supply a sufficient number of waggons, some parts of the annual workings have not been felled in the prescribed year, and the fellings have consequently fallen into arrears.

Each coupe is about a thousand acres in extent, and the yield is about 3000 cubic feet per acre. The fuel is disposed of by contractors at about Rs. 17 per stack of 600 cubic feet, a large proportion being bought by the railway. The price paid by the contractors varies between Rs.5 and Rs. 25 per acre according to the distance of the coupe from the railway, and it has been lowered in past years by the contractor knowing that though he buys the entire plot, he will probably have to leave a part of it unworked. These parts of the coupes which remain uncut are resold a second, and sometimes a third, time.

This Coupe V, which the students visited, was not all worked in one year as it should properly have been, but was worked in parts during three consecutive years. A map is kept on a large scale showing each year the areas actually worked over.

The work in this working circle is now (1902-1903) just one coupe in arrears, but with an improved supply of railway waggons it is hoped this year to work two coupes and so get straight again.

A revenue of Rs 6000 per annum is made in this Bhira Range from the sale of Bhabar grass, *Ischæmum angustifolium*. It sells at Re.1-5-0 per maund delivered on the railway. It is said to be best when cut in the rains; the fibre is then strongest, and it retains a pale green colour. It is cut, dried, shaken out, and then twisted into hanks, which are exported for the manufacture of ropes, matting, paper, etc. In other places this grass is always harvested in February and March, because in the rains it is mixed with young sappy blades and the last year's grass has lost some of its strength.

Charcoal Kilns.

At Marha the students saw a camp of twenty charcoal kilns of an unfamiliar kind, which appears to give good results in places

where a large supply of wood renders the labour employed in burning the charcoal of more importance financially than the cost of the wood burnt.

These kilns are used several times.

The first time, the wood is stacked in the ordinary way into a small hemispherical mound, and covered over with a thick coat of mud overlying a first cover of leaves.

This kiln is burnt without any chimney, and the shell of mud is not beaten down as the wood subsides, but is cooked into a hard crust forming a sort of permanent oven. Each kiln, which is paraboloid in shape, is 6½ feet high and 13½ feet in diameter. The crust is about six inches thick, and the floor is the natural level ground.

The wood, which is green, and includes some huge old hollow pieces of sal of three or four feet girth, is stacked on end vertically with other pieces laid on the top. The billets are about two feet in length.

The kiln thus contains 75 maunds of wood or 150 cubic feet solid.

The burning takes ten days, and after leaving it two days to cool, the kiln is opened by breaking a hole through one side of the baked crust, and about 27 maunds of charcaol is obtained.

The first burning yields a poor outturn both in quantity and quality.

Next time, the kiln is restocked by the door broken in one side, and billets of wood are again stacked inside: the doorway is then built up again and smeared over thickly with wet mud.

The kiln is fired from a hole at the bottom on the side from which the wind is blowing. The fire passes upwards to the top of the stack, and there spreads into the wood all round and thence burns downwards. There are holes left in the crust of the kiln, a few rather large holes on two levels, which are gradually closed from above downwards as the fire spreads to the lower part of the kiln. There are also holes left on the ground, which are the last to be closed. After the first burning, the mud crust is burnt dry, and is absolutely air-tight. Any cracks are filled up with mud, and the whole kiln is kept luted over.

Only waste wood—wood too big or not fit for sale as fire-wood—is carbonised. The interstices between the billets in stacking are not filled in: the labour is the only real expense, and a little waste of wood is of little consequence.

The wood practically costs the contractor nothing, as it is only waste pieces.

The cost of cutting the wood for burning one kiln is Rs.2, and the cost of burning the kiln is Rs.2.

The yield is 27 maunds of charcoal, which after paying one anna per maund for cartage to Mailani, sells there at Rs.50 for 180 maunds.

The total cost is therefore about Rs.5-11-0, and the receipts Rs.7-8-0, or the profit on each burning Rs.1-13-0.

Coppice Working.

Until a short time ago, almost the entire produce of the Marha coppice working was exported as fuel, as it was thought unwise to allow the contractors to sell timber to outsiders inside the coupe on account of the temptation to fell standards.

A system has therefore been lately applied by which every tree of three inches or more in diameter, which is possibly fit for use or sale as timber, felled in the coupe, is marked with a hammer, and the standards reserved are marked with black paint only.

With this safeguard against abuse of the permission to sell timber locally, a considerable trade has arisen, and the contractors now recover the greater part of the money that they have paid to Government for the coupe from traders, who come with carts from distant places to buy small timber.

There is no longer any waste therefore in cutting up into fuel wood capable of being used for small timber.

The contractor saws up into metre-gauge sleepers the thickest sal logs, but they are seldom free from sapwood, and only sell for Rs.1-1-0. The price of first class sleepers is Rs.1-12-0, and of the second class Rs.1-6-0. These sleepers are passed and marked by the Ranger before they are moved away from the stump, so that no standards can possibly be felled for this purpose.

The principal produce of this forest however is fuel, chiefly for the railway. In executing the felling, all trees, including the smallest seedlings, are cut for the sake of uniformity in the new crop. The railway only takes sal fuel; wood of miscellaneous kinds is all exported to Bareilly, Lucknow and other large cities.

The coupe now being felled sold for ten rupees per acre, and the outturn is about 3000 cubic feet per acre.

The coupe is divided by lines into four plots. Temporary wells are sunk by contractors wherever required, as the water level is only 8 or 9 feet below the surface. The felling is mostly done by hillmen. One contractor, however, imported Bareilly men, as they are better workmen and use very heavy axes (7lbs.).

One Bareilly man can cut a quarter of a stack of fuel per diem, and thereby earns one rupee: this work would take two local woodmen, or four Paharis, to do.

SYSTEMATIC MARKING OF STANDARDS.

The working-plan does not go into much detail on the subject of the reservation of standards. It merely lays down a minimum of 50 trees per acre, or 75, if Vth class trees have to be reserved. A tree of three rotations' age is reckoned for the present to be exploitable.

On an average about 55 trees have been reserved per acre.

If the plan is to realise 20 standards of 72 years old per acre at each felling, it would have been the right thing to reserve about 30 trees of two rotations' age, and 40 of the age of the coppice; total 90 trees.

This would have allowed for casualties; and several trees are always broken in the working; it would also have given further opportunity for continuing the selection of those trees which are considered to be worth reserving for a third rotation.

Formerly the marking of standards was always done by eye, and the result was that the number reserved per acre was very variable, according to the personal idiosnycracies of the marking officer. As a rule the tendency was to reserve too may standards, in which case the coppice suffered proportionately.

In the Kheri Division now every square chain of the coppice coupe is measured out, and six trees selected therein to allow for trees which may afterwards be accidentally broken. This may sound rather unpractical, but in reality it takes no time at all.

The whole coupe is gone over in strips parallel to one side; four boys hold cords of a chain's length along the sides of the strip, while a cooly marks the outside of the line by cutting branches along it; there are also two other cords of a chain's length going cross-wise across the strip, so that as the marking officer goes down the strip, it is all divided up successively into plots of one square chain, in each of which he selects six standards.

One marking officer can do 15 acres a day. By this means the standards are perfectly uniformly distributed over the whole area, and are more or less equidistant one from another: another practical advantage is that the contractor knows exactly how, and in what number, the marking of the standards has been done, and he will therefore have more confidence in bidding high at the sale.

The standards are supposed to be of two sizes (24 and 48 years old), but practically they are reserved of almost any size.

In grassy places there may be practically no choice, as there may not be more than six trees altogether growing on the square chain, in which case nothing can be cut.

This systematic selection of standards may sometimes result too in the reservation of trees unworthy from a timber-producing point of view, but selected purely on account of their position.

No statement regarding the size or species of the standards marked is kept: in last year's coupe the crop looked rather open on account of the small size of the majority of the trees reserved, and there might possibly be a little danger of frost penetrating.

On the whole there is no doubt that this systematic method of marking standards is an admirable one in every way. The difference in the appearance of two coupes, one marked by eye and the other by this system, is very noticeable, and shows the advantage of the new method.

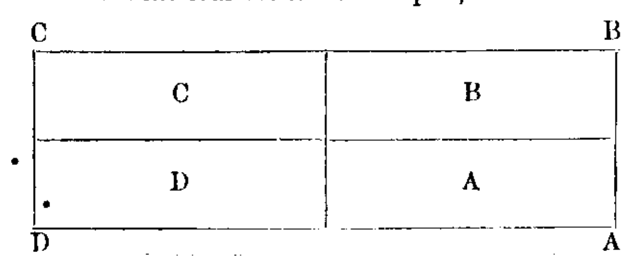
Sample Plot.

The students laid out a sample plot in this year's coppice area at Marha in accordance with the orders abovementioned.

A typical piece of forest was selected and laid out in rectangular form, five chains in length, parallel to the road, from which it is separated by a protective screen 40 feet wide, and two chains in breadth. It was found to contain 57 standards. The plot was laid out by chain measurement, and a narrow trench dug all round to mark the perimeter. It was also divided across into four equal quarters.

The trees were first numbered with white paint on a scraped surface of bark. They were then ringed with white paint at 4 feet 6 inches from the ground, avoiding all bumps and irregularities of shape, and always ringed at right angles to the axis of the tree. This is done by scraping the tree clear of projecting roughnesses and tying a string tight round the place chosen, and then painting a band up to the level of the string.

The position of each tree on the ground is then measured by co-ordinates from the four corners of the plot, and thus recorded :—



The four quarters of the plot are called A, B, C and D.

The list is as follows:—

1.	A	9	13	17.	B	2	5
2.	A	10	15	18.	B	6	12
3.	A	8	17	19.	B	7	17
	etc.				etc.		

The first number shows the distance of the tree measured from its corner along the longer side of the rectangle, that is, from A or B in the direction of D or C, and *vice versâ.*

The second number gives the offset at right angles to the longer side of the rectangle, that is, the distance of the tree from the perimeter of the plot measured parallel to the shorter side.

Tree No. 1 is therefore in A quarter at a point 9 feet distant from the base A B, and 13 feet distant from the side A D.

Tree No. 19 is in B quarter, and is found by measuring 7 feet along B C, and then taking an offset of 17 feet at right angles.

The girths and heights of all the trees are then carefully measured and recorded.

PONTOON BRIDGE OVER THE SARDA RIVER.

The railway extension from Mailani to Sonaripur, 32 miles, which is soon to be carried on to Katarnian Ghat, is at present practically a forest line merely, which is closed for half the year in the rains.

The Sarda is a river which shifts its channel from time to time, and there is therefore no permanent bridge over it.

The river crosses it at present on a temporary bridge, which is dismantled every year at the beginning of the rains; it is built on piles for the shallower half of the river bed, and continued on pontoons across the deeper part. The piles are made from II class sal trees specially selected from the forest and supplied to the railway at the rate of fourteen annas per cubic foot. The pontoons are seven in number. They are of iron, and are 50 feet in length and 20 feet in breadth. They are anchored in line across the stream 50 feet apart. Each pontoon carries a section of the bridge of 50 or 20 feet alternately in length, fixed on a vertical shaft, in the centre of the pontoon. These sections of the bridge, iron girders, are then swung round into line, and connected by horizontal steel pins, from which they swing. As the train passes over the bridge, each pontoon is depressed about a foot into the water by the weight of the engine and train, and the rail can thus undulate to a slight extent without any harm resulting.

NEW WORKING-PLAN OF TRANS-SARDA FORESTS.

The old working-plan of these forests prescribed fellings up to the end of the season 1901-1902, and its place is now taken by a new plan, which will come into force on 1st July 1903.

This forest is divided into two working circles, east and west, both worked under the Selection method, with a 30 years' felling cycle and annual coupes in each of about 1500 acres.

The sal forest is exclusively on the high alluvium. The low alluvium, the later deposit, contains nothing but grass, with shisham, khair and scrub jungle.

		Sq. miles.
High alluvium ...	Sal forest	143
	Grass	56
Low alluvium ...	Shisham and khair	20
	Various	20
	Grass	34
		267

The high alluvium or sal area is again divided into high level and low level.

There is not very much difference between these two types, but on the high level the forest is better stocked and the soil is more clayey. On the low level, the soil is more sandy, there is more grass, and frost and fire have done more harm: the forests, however, being less good than those on the high level, have been less worked.

The whole country is flat, with a gentle slope of three feet per mile to the south-east. The average cold weather water-level is 33 feet below the surface on the high level areas, and about 15 feet down on low level areas.

High alluvium sal area.	Stocked.	Fire lines.	Grass.	TOTAL.
High level...	29,203	272	70	29,545
Low level	61,233	759	35,600	97,592
	Total acres ...		127,137	

Sal forms nearly three-fourths of the stock, and *Terminalia tomentosa* nearly one-fourth. The latter tree occurs principally on low ground; the timber is of less value than that of sal, and is nearly all exported to Meerut, where, it is said, white ants do not eat it. It is very good in quality, but the general state of reproduction at present is poor.

The annual yield is fixed at a maximum of 12,000 sal trees: this is probably less than the possibility, but the forest is not fully stocked, and it is intended to raise the exploitable size from 6 feet to 7 feet 6 inches girth.

For the first half-period of 15 years, the exploitable size is taken as 6 feet corresponding to 120 years of age, but it is intended then to raise it to 6 feet 9 inches.

This raising of the exploitable size would seem to be rather premature in the absence of any reliable data as to the size to which under existing conditions sal trees can grow without beginning to become unsound.

The trees are marked for felling a year in advance, and an estimate is then made of the expected outturn of sawn timber from the coupe. This estimate is based on figures obtained from past workings, which roughly give 30 cubic feet and 5 cubic feet respectively for each sound and unsound I class tree: sal, sain and haldu are sold separately. If necessary the coupe is allowed to be kept open for export during the year after the felling, and in the following season,--two years, that is, after the felling—subsidiary fellings are made for the removal of old worthless trees and of trees of inferior species suppressing young sal growth, while badly grown or damaged young trees are cut back flush with the ground, and climbers are cut.

These subsidiary fellings are very important, as can be well seen at Dudwa, for if only the marketable trees are extracted and a large quantity of old unsound trees left to cumber the ground, these latter can only be afterwards removed at the cost of incalculable damage to the young growth around them.

WORKING OF THE FORESTS.

The principal produce of the forests is sal metre gauge sleepers ($6' \times 8'' \times 4\frac{1}{2}'' = 1\frac{1}{2}$ cubic ft.), of which seventy thousand were exported last year.

Until recently the railway worked the forests by their contractors, and paid twelve annas per cubic foot on all sleepers extracted. The railway paid their Delhi sawyers seven annas for first class sleepers, and two and one anna respectively for second and third class sleepers. ... ...

The normal price for sawing sleepers being four to five annas, the workmen naturally tried to confine their work to the conversion of first class sleepers, and consequently a large amount of unsound and unconverted timber was left in the forest.

Each coupe therefore had to be resold afterwards a second, and often a third, time, to be again worked for the extraction of the refuse timber it contained. There are many obvious disadvantages connected with this mode of working, in addition to the fact that all felled timber barked and left lying in the forest is at once attacked by large longicorn beetles.

This has been all changed now by the introduction of what is known as the monopoly system, which was started last year with outside contractors, though the railway continued working for one season under the old arrangement of paying twelve annas per cubic foot on all timber exported. The forests are now worked entirely under this admirable system.

As soon as the coupe has been marked, an estimate, as stated above, is made of its probable yield. There is a regular sanctioned scale of export rates detailed for every variety of converted timber; this royalty is debited against the purchaser's account as each cartload of sleepers, beams or scantlings passes the forest chowki on its way out of the forest.

The intending contractor or purchaser, being familiar with this scale of export rates, is able to calculate, on seeing the coupe and the estimate of its produce, how much in addition he is able to bid to buy the exclusive right to work the plot or group of plots which are offered for sale.

The monopoly price at present works out to about two annas per cubic foot on the outturn, or about one quarter of the whole price, as the greater part of the sawn timber extracted comes under the category for which six annas per cubic foot is due.

Instead therefore of taking out only the best timber at a comparatively high rate of royalty, and leaving everything else lying in the forest, the contractor under the new system, having paid down a considerable lump sum for the monopoly of his plot, which sum he has to pay whether he works the plot or not, has every incentive for working out as much timber as possible from it, and in practice nothing but wood worth less than three annas per cubic foot—fuel that is—is left in the forest to waste.

The monopoly price too allows for differences of distance from the railway and of productiveness of the locality, which cannot so conveniently be allowed for in the printed scale of rates for export duty.

Five Range Forms are kept up, showing details regarding the working of the year. Form I is simply a list of all trees felled, showing a serial number for each tree and its girth.

Form III is a form for conversion, and shows either logs in the round with their girth, or scantlings of various dimensions. The number of pieces yielded by each tree is thus separately shown, and the progress made day by day in the work in the forest is shown as it goes on.

The annual compilation of these returns gives very reliable yield tables for the forests of this locality.

Form V is an export form, and shows the number of pieces of all sizes removed from the forest by each contractor. The clerk at the forest chowki examines each cart as it passes, puts the *sold* mark on the timber, notes the name of the cartman, and the number of pieces it contains. The royalties on each class of scantling are entered and totalled, and the amount subtracted from the contractor's deposit, and his balance stated. Each contractor has a separate book of Form V.

Form II gives the monthly totals of Form V, and must always give smaller returns than Form III.

Form IV gives the monthly totals of Form I.

In addition to the hamner-marks which the forest gang clerks—who keep Forms I and III and are under the Ranger's orders, though paid for by the contractors—put on the sleepers and pieces at each stage, there is also a serial number put on every stump in the forest in red paint, and the same number is painted on all sleepers and scantlings made from the tree. These paint marks are only for use in the forest for checking Form III, before the timber is removed from the ground where the tree was felled, to show which tree yielded any particular pieces of timber. They are of no use when once the timber has been removed from its original spot.

Execution of the Fellings.

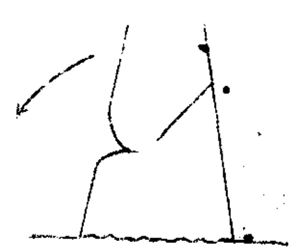
The work in these forests lasts for seven months in the year, from the 1st December to 30th June; sawing is allowed only to the end of March, but carting is allowed to end of June. The sawing is largely done by Delhi men, who work very well: two men can saw up five or six metre gauge sleepers a day out of green sal logs.

The felling is done by saw and axe combined.

A ring of bark about a foot wide is first taken off the tree at the level where it is going to be felled.

Then a notch—not a very large one—is cut with the axe out of the side towards which the tree is leaning, or out of the side towards which direction it is desired that the tree should fall if it is standing straight and pretty evenly balanced.

An oblique sawcut is then made on the other side sloping downwards towards the centre of the tree.



No wedges are used, as the weight of the tree aided by the notch cut out of the other side keeps the sawcut open, so that the saw works quite freely.

The saw used is not the broad curved Delhi saw, but a less curved, narrower and more flexible saw of only about three inches in width at the widest end.

A sonnd sal tree of ten feet girth was felled in 23 minutes by two men.

For purposes of conversion, the advantage of the Delhi shape of saw is best seen when it is being used in a vertical plane.

Instead of having to dig a hole in the ground for the men holding the lower end of the saw to work in, as the Gorakhpuris do who use frame saws, the Delhi man simply sits on the ground, and works his back, legs, and arms just like a man sculling.

Although the saw is curved, it produces an oblique cut in a straight line through the wood.

The Delhi saw costs Rs. 3-8: it is said to be made out of old railway rails hammered out. The teeth are filed and set two or three times a day. The setting is not done by a key, but by two small hammers; every fourth tooth is set alternately right and left.

Large hollow sal trees are used for boat hulls; they only cost about Rs. 75 each to make and export, and they sell at Bahram Ghat for nearly double.

These logs are often about twelve feet in girth, and cube nearly two tons.

They are hollowed out, and then stretched open by firing the under surface, in the same way as teak hulls are made in Burma.

In measuring the girth of a standing I class sal tree seven inches is allowed for the bark.

In the conversion of kurries of *Terminalia tomentosa*, it is to be noticed that the sapwood of this species being considered by the natives to have greater transverse strength than the heartwood, which may sometimes be rather brittle, they always try to keep some of the sapwood on their beams.

FIRE-PROTECTION.

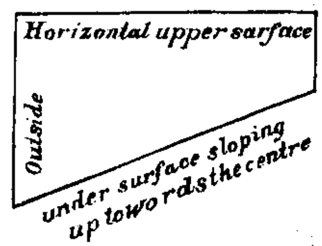
The Kheri forests are intersected by a very well developed network of fire lines.

These are cleared in November and burnt at the end of December and January. By the end of January the young grass springs up, and the fire lines are green.

The vast extent of grass areas which intersect the whole forest, would constitute a great source of danger from fire if they were not burnt every year in self-defence. They are accordingly all fired in January, but a belt of 200 feet of grass is left all round the edge of the forest to encourage tree growth therein. The sal trees round the *phantas* are not likely to produce seedlings at any distance greater than this.

WELLS.

The-water level being at a uniform distance below the surface of the ground, and never deeper than 40 feet down, even on the high level, permanent wells can be easily sunk throughout the forest wherever they are required. The average cost is about Rs. 100 for every ten feet of depth ; thus an ordinary well with the water at 30 feet below the surface and 20 feet of water in it, costs Rs. 500. The well is first dug out until the water-level is reached, and then the well-curb, made of pieces of *Eugenia jambolana* wood, with a section as here shown, is laid down, and ten feet of brick cylinder is built up on it. This cylinder is then sunk down to water level by digging out the earth from the bottom under the curb, whose sloping under-surface presses the earth into the middle of the well.



The brick cylinder is then built up another ten feet in height, and the whole is again sunk down to water level, so that there is always twenty feet of water to start with.

SYLVICULTURAL NOTES.

It is probably safe to say that almost without exception every sal tree in these forests is sprung from a coppice shoot.

If any young seedling, or what appears to be a young seedling, be dug up, it is found to be growing on a thick bulbous stool, possibly thirty or even forty years old.

If it is, as appears at first sight, an inevitable part of the plan of nature that all young sal growth should thus be always thrown back, say, even 20 years, this fact is obviously of the greatest importance in designing a systematic treatment to be applied to a forest, especially if the cultural mode of treatment were the regular method, with successive regeneration fellings and single-aged crops. The possible causes of this untoward habit are therefore worth considering.

Suppression from want of sufficient direct sunlight naturally suggests itself in this connection.

The sal is reputed a shade-bearing species, and it certainly can exist without much light, but to grow it requires direct sunlight. Perhaps the more vigorous growth of the sal in Kheri renders it more light-demanding than it is in the Dun.

The thick sappy carrotty stems that shoot up when, after a long lapse of years, the swollen underground stem throws up a strong vigorous shoot that now at last will survive and continue to grow, seldom, if ever, are seen (at any rate in Kheri), under cover of surrounding growth, but only under direct sunlight. The result of improvement fellings too is most striking, and the removal of worthless and unsound trees with spreading crowns has everywhere resulted in a splendid growth of young sal, which was only waiting for more light. Even the clearing away of bushes of *Mallotus philippinensis*, under which suppressed sal seedlings are often found, has been found to assist in raising a crop of young sal.

It is incontestable therefore that the young sal plant requires light for its growth, but the action of overhead cover alone will not satisfactorily account in every case for the periodic (it is not necessarily annual) dying back of all young sal plants, since the phenomenon is equally common and noticeable in open grassy places, and round the edges of blanks where there is absolutely no shade at all.

The failure to tap the permanent water-supply has also been suggested as a possible reason for this waste of production, and would in many respects fit the case.

What more natural than that the young plant should be withered and scorched up by the dry winds of the hot season, so long as its roots are only yet working their way through a great depth of loose sandy soil and have not yet reached the water-level?

It is to be remembered, on the other hand, that the best grown sal is on the high level area, where the water-level is about three times as far below the surface as it is on the low level. On water-logged soil sal will not grow at all, and in places where the water-level is not far below the surface it is natural to suppose that the length of the taproot and the length of the trunk are in a direct proportion, and it is certain that if the water-level is near the surface, the sal tree is stunted.

Moreover, the most active period of the sal's vegetation is just in the driest time of the year, and at the end of March the striking phenomenon is seen of a tuft of green leaves appearing a short way below the terminal shoot, before any other part of the young tree has put forth its new leaves. Whether the habit which the sal has in the pole stage of periodically replacing its leading shoot, which dries up, by an extra vigorous side shoot,

is to be attributed to the same cause which results in the periodic dying back of the young shoot which springs from the ground for many years in succession, is a point to be decided by careful observation.

If drought caused this repeated dying back for the first 20 or 30 years of the life of the young sal, it is difficult to understand how the subterranean part of the plant continues to grow in vigour and succulence all the time, and this same objection holds with reference to suppression from want of direct sunlight.

Other possible causes for this habit are frost, fire, grazing and injuries from men and animals, and lastly insect attacks. Frost would readily account for this natural coppicing of the seedling if all parts of the forest were exposed to frost, but as large areas of sal forest are never touched by frost, but still suffer everywhere from the periodic and continual dying back of sal, it is evident that frost alone will not account for it. A similar argument disposes of fire, grazing and external injuries from men and animals, because, although any of these reasons might readily produce this result, yet the same thing is frequently observed in places which have been successfully protected from fire for many years, and which have not been exposed to any direct injuries from cattle grazing or working in the forest: besides, we see the same thing happening when the tree is well advanced in the pole stage, and the leading shoot often dries up and is replaced by a strong sappy side shoot.

Lastly, we have to consider insect attacks. The scale insect swarms in the sal forest at certain times of the year, but so far no connection has been proved between its ravages and this habit of the sal tree. Common as it is, it is hardly credible that this insect should be so universal that no part of the forest should ever be left undamaged by it.

A significant point to observe too, both in connection with the *monoflebus* and some of the other suggested causes of this habit, is that the buds which are going to supply the side shoot on its drying up, are already well developed and clearly visible long *before* the leading shoot has begun to lose its leaves, or to show any symptoms of the fate which is awaiting it.

Possibly a combination of some or all of the above-mentioned causes may account for this unfortunate habit; it is conceivable for example that an insufficient water-supply might, to begin with, diminish the seedling's vigour of growth, and then that accidental fires, or deer browsing, or insufficient overhead light might eventually result in its dying back.

The habit however is so universal that the cause would seem to be something more far-reaching than any external injuries can

be, and the only way to satisfactorily settle the question is to sow a nursery bed and to carefully watch the development of the young trees as they grow up.

Meanwhile, this habit of the sal of continually dying back, and thereby losing perhaps 20 years of growth in its earliest stage, is quite sufficient to upset any working-plan that ignores this fact.

RESULTS OF IMPROVED METHODS OF WORKING.

The increase of revenue in the Kheri Division last year resulting from the introduction of the monopoly system in the trans-Sarda forests, from increased export of timber by contractors in the Bhira forests, instead of cutting up everything into fuel, and from the rise in the value of the coppice coupes, consequent on the introduction of the systematic method of marking standards, is nearly Rs. 87,000.

In the Bhira Range, while the average annual revenue was formerly Rs. 15,000, the present revenue is nearly Rs. 45,000, and will probably next year be Rs. 60,000.

In the Kairigarh Range, however, the outturn will be only one-third of the estimated annual outturn, which is two lakhs of cubic feet, or one and a half lakhs of metre gauge sleepers, owing to the large proportion of old unsound trees in this year's coupe. However this decrease will be counter-balanced by the improved revenue in Bhira Range. Until recently the second and third year's fellings over each coupe were necessary, because the railway only extracted the best timber, which it paid them to work out at twelve annas a cubic foot, and left everything else lying in the forest, and also because the coupes were so large.

The best thanks of the School are due to Mr. P. H. Clutterbuck, the Divisional Officer, to whose kindness and good management the tour in Kheri was both extremely enjoyable and instructive.

All information regarding the forests and their working was freely given, and the matter contained in these notes is almost entirely derived from his explanations.

H. J.

The Insect World in an Indian Forest and how to Study It.

BY E. P. STEBBING, F.L.S., F.E.S.

Continued from p. 148.

PART VI—*(continued).*

ORDER.—*LEPIDOPTERA*—*(continued).*

SUB-ORDER HETEROCERA (MOTHS)—*(continued).*

FAMILY COSSIDÆ (CARPENTER WORMS).

THE Cossids are moths of large size having no proboscis. They have frequently a dense covering of matted, imperfect scales on their wings, the pattern being vague. The larvæ are often large, are nearly bare of hairs, and have no bright markings. They bore into trees, often making large ramifying burrows and boring holes to the exterior, from which the sap exudes and runs down the bark outside, serving as an indication of their presence. These larvæ often attain a length of several inches and may live for several years in this condition, mining up and down in the wood of the tree. The pupa is formed within a slight cocoon of silk mixed with gnawed wood. It is furnished with spines along the dorsal surface of the abdomen, by means of which it can move to a certain extent up the tunnel.

This family requires serious study in Indian forests. One or two pests are already known, and it will not improbably be found that others are a serious menace to young saplings, attacking and riddling them before they have grown to a size sufficient to escape damage from the pest.

A species of this family named *Cossus cadambe* has been reported as attacking lopped teak trees in Travancore. The tree is found on considerable areas both in the low country and on the hills up to 3000 feet elevation. The teak over this area is largely lopped for fodder, and in the rotten wood which forms by decay at these wounds, the moth lays her eggs about April. The larva is smooth, without hairs, and red in colour; it probably spends over a year boring inside the wood. The tunnel formed is a winding one. The pupa is apparently not enclosed in a cocoon. It is spiny, the spines being made use of to enable it to work up the tunnel to the opening to the outside, thus enabling the moth to creep out of the hole originally bored to the outside by the larva for this purpose.* When trees are badly attacked they are said to die down, only the base of the stem remaining, which throws out suckers.

The well-known coffee-borer of Southern India, *Zeuzera coffeæ*, belongs to this family, the larva feeding in the coffee

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* *Vide* Injurious Insects of Indian Forests, p. 102, fig 67.

branches and stems and, it is said, in the roots, and killing them off. It is also said to attack the stems and roots of the sandal-wood, young saplings of this tree being either killed outright or so weakened that they were thrown down by the first storm.

The writer has had an opportunity of examining both coffee and sandal-wood in the Madras Presidency, both young saplings and older trees, and his investigations, although they have not been carried far enough at present, lead him to suspect the real pest of these trees and the one which causes the most serious injury is a longicorn grub (*Cerambycidæ*) which attacks the trees in their sapling stage, and, usually starting in a branch, works its way down to the heart of the stem, perhaps hibernating in the cold weather in the roots. Whilst the coffee boring caterpiller undoubtedly does damage to both coffee and sandal-wood, investigations will not unlikely show that this damage is by no means so severe as that done by its beetle grub companion. Since on the one hand coffee bushes are killed off or are so riddled as to be useless by the grubs, whilst on the other the tunnels in the heart of the sandal sapling whilst perhaps not killing the plant reduce the value of the wood for sale purposes when the tree is finally cut over, it becomes obvious that it is imperative that the habits of these borers should be thoroughly understood.*

FAMILY HEPIALIDÆ (GHOST AND SWIFT MOTHS).

Moths of varying size, some being gigantic. The wings do not fit well together at their bases; no proboscis is present and no frenulum; the scales on the wings are imperfect. The larvæ are nearly bare of hairs, and they live either in the earth, feeding upon the roots of plants, or they burrow in the wood of trees and shrubs. The chrysalis is generally elongate and cylindrical in form and very agile, having a considerable number of spines on its dorsal aspect; by the aid of these the pupa is able, by wriggling, to move a considerable distance in the tunnel in the wood.

Very little is at present known about the operations of these moths in Indian forests, but grubs thought to be Hepialid have been reported as boring into teak wood at the Nilumbur plantations and into young teak saplings in plantations in the Prome division. These reports require careful observation and confirmation.

The eggs in this family as well as in the families *Ægeriidæ* and *Cossidæ* above alluded to are usually laid upon the bark. The caterpillar tunnels into the wood. The tunnels so made are kept open by the larva and it occasionally comes out and feeds upon the bark. It often builds for itself a covered gallery of silk and excrement, this gallery being very conspicuous on tree trunks. When it feeds in this way the tree attacked will be often found to have a juicy, soft succulent bark.

* *Vide* Injurious Insects of Indian Forests, p. 104, fig. 68.

FAMILY LASIOCAMPIDÆ (EGGERS, LAPPET MOTHS).

These moths are usually large, are densely covered with scales, and have no frenulum. The costal area of the hind wing is largely developed. Antennæ in the male are highly pectinate. These characters render it easy to distinguish a Lasiocampid moth. There is at times a great difference in size between the male and female, the latter having three times as great an expanse of wing as the male. The eggs are smooth and sometimes spotted in an irregular manner like birds' eggs. They are often covered with hair by the female. The larvæ are clothed with a soft woolly hair as well as with short stiffer hairs. These hairs are not arranged in definite tufts and pencils, nor are they as highly coloured as in the case of the larvæ of the next family to be considered, the *Lymantriidæ*, and thus they can be distinguished from these latter. This hair has sometimes very irritating properties. The caterpillar spins a cocoon in which the hairs of the body are often mixed. In some species the walls of the cocoon have a firm appearance, looking very like egg-shells, and this has probably given rise to the name of 'eggers.' The caterpillars feed upon leaves and probably do some damage in this way.

An example of one of these Lasiocampid defoliators is an insect by name *Suana concolor*, whose larvæ feed upon the leaves of the sal tree in the Siwalik Forests in the United Provinces.

The larvæ caterpillars of this insect are large, over three inches in length when full grown in October, and grey in colour, with irregularly arranged tufts of soft hair. They pupate in November, spinning a strong hairy silken cocoon on to the bark or a branch of the tree. The winter is spent in the pupal stage, the moth appearing about the end of March. The rest of the life-history has yet to be worked out, but the female probably lays its eggs on or near the sal twigs, and the young caterpillars hatching out feed upon the new flush of leaves which appears in April. The moth is grey in colour and answer the above description of a Lasiocampid moth.*

FAMILY LYMANTRIIDÆ OR LIPARIDÆ.

Mostly small or moderately-sized moths, without brilliant colouring, whites, greys, browns and blacks being the predominant tints in the family; the male has the antennæ highly pectinated. The larva is very hairy and usually bears tufts or brushes of shorter hairs together with others much longer and softer, these being sometimes amalgamated to form pencils, the tufts and pencils having a definite arrangement on the insect. The colouration of

* *Vide* Departmental Notes on Insects that affect Forestry, No. 1, p. 58, Pt. V, fig. 1 a, b, c, d, for a description of the life-history of this insect.

the larva is often very conspicuous, the tufts and pencils of hair being of vivid and contrasted colours. This arrangement and colouration of the hairs distinguishes these larvæ from Lasiocampid caterpillars. Any one who has been in tropical or semi-tropical forest at the commencement of the monsoon, must have noted the great variety and brilliant colouration of the caterpillars of this family. The writer was particularly struck with the gorgeousness of what may be termed the 'grub world' at this season in both the Berar and Coimbatore (Madras) forests, whilst he was visiting them at this period of the year.

The larvæ form a cocoon in which much hair is mixed up. The pupæ are very remarkable, as they are sometimes also hairy, which is very unusual amongst Lepidoptera.

This is an important family of moths, as it contains species which occasionally increase in enormous numbers and commit great ravages. One of the first allusions to such an event having taken place in an Indian forest is contained in a description, by Mr. W. R. Fisher, * late Conservator of Forests, of a severe attack, in which the trees were completely stripped by one of these insects, which took place in the sal forests in Assam in 1878. The egg is laid by the female moth on the young leaves of the tree. The caterpillar on hatching out at once commences to defoliate the trees, and in the attack in question an area of over 200 square miles of sal forests was completely stripped of all leaves, the trees being rendered perfectly bare and the ground being strewn with their debris, and with the caterpillars' droppings. In 1897 Mr. Campbell† reported an attack to have spread over 800 square miles in Assam, all the trees associated with the sal, such as *Bombax malabaricum*, *Careya arborea* and *Dillenia pentagyna*, etc., being also defoliated ; at the same time he noted that pure sal forest had suffered more than mixed. In this attack the larvæ first appeared in August, a second generation appearing in November, a third about the end of January and a fourth towards the end of March. The chief insect responsible was a species of *Dasychira*. This insect was accompanied by *Leucoma diaphana* in August, by *Trabala Vishnu* in May and by *Lymantria grandis* in all the attacks.‡ In 1899 all the sal trees in the Duars in Bengal were defoliated in a similar manner, four different species of *Lymantria* moths sent to the writer by Sir H. A. Farrington, the Officer in Charge of the forests, and identified by Sir George Hampson, being concerned in the attack.§ It is not certain how many species or what moth was responsible for the Assam defoliation, as confusion appears to have arisen in the identifications of the insects sent.

* *Vide* Indian Forester, Vol.

† *Ibid*, Vol. XXIV, No. 9, (1898).

‡ *Vide* Departmental Notes on Insects that affect Forestry, No. 1, p. 63.

§ *Ibid*, pp. 67—77.

From what has been written it will thus be seen that species of this family, when they swarm in large numbers, are a source of serious danger to the forest.

FAMILY GEOMETRIDÆ (GEOMETERS).

An extensive family of fragile moths having a large wing area, the antennæ being frequently highly developed in the males. The larvæ are elongate and slender, having in addition to the three pairs of thoracic legs, only one pair of abdominal pro-legs placed on the ninth segment and an anal pair. They progress by moving these two pair of feet up to the thoracic legs, so that the body is thrown into a large loop, and then moving forward the thoracic legs. From this habit of progression they are called 'loopers' or Geometers. The number of these larval legs and the resultant mode of walking is one of the most constant characters of the group. The larvæ assume various attitudes in repose, either clinging to the stem with their pro-legs, holding the rest of their body straight out at an angle from the twig, being attached to it anteriorly however by a strand of silk projecting from the mouth; or they prop themselves up between two twigs more or less at right angles to each other. They often vary in colour, the same species being either green or brown, and this colouration and the markings upon them often gives them a great resemblance to their food-plant, but in many cases they appear to make no or little use of this for protective purposes, as one would expect to find them doing.

These larvæ are defoliators, but little is known about their operations in Indian forests at present. The following is a portion of the life-history of a typical member of the family by name *Boarmia selenaria*:—

In the sal forests of the Siwaliks (on the Dun side of the range) a plague of caterpillars appeared about the middle of April 1901 and in parts entirely stripped the trees of all the new year's shoots, leaves and flowers. Young saplings suffered very severely, and the writer noted that towards the end of September they had no green shoots upon them, many bearing numerous dead branches. The growth of the year in the portions of the forest most heavily attacked was *nil*. Sal of all ages were attacked. The pupal stage was a short one, and moths were bred out in May. There is probably more than one generation of the pest in the year, but observations on this head have to be yet made.*

NOCTUIDÆ (NOCTUIDS).

A very large family of moths, generally of sombre colours, the insects being, with some exceptions, very rarely seen in the

* *Vide* Departmental Notes on Insects that affect Forestry, No. 1, p. 100, Pt. II, figures 5, *a*, *b*, *c*, for a further note upon the habits of this insect.

daytime. Both proboscis and frenulum are present, and the antennæ are not highly pectinated in the male. About 8000 species are known, and owing to their great resemblance their classification is difficult. The larvæ are, as a rule, destitute of large tufts of hair and are not brilliantly coloured; they are fond of concealing themselves during the day and coming out to feed at night, and thus when defoliating trees they are very apt to be overlooked, as when searched for during the daytime they are not to be found upon the leaves and twigs. Many of the caterpillars of the family pass most of their time at or beneath the surface of the ground, finding nourishment in roots or the lower part of the stems of plants. This is especially the case in the genus *Agrotis*, perhaps the most widely distributed of all the genera of moths. In some forms the abdominal pro-legs are reduced to two in number, and we then get larvæ resembling the loopers of the last family, the caterpillars being then known as 'semiloopers.'

Noctuid larvæ either defoliate trees and plants, or they may have a limited wood-boring capacity. Others feed in the seeds of plants or live upon the roots, either feeding upon the smaller ones or tunnelling into the larger ones. The larvæ living upon leaves are usually hairy to a certain extent, and spin a cocoon before changing into the pupal state; those living in wood form a rough cocoon of hairs and chips of wood, whilst those pupating in the ground usually build an earthen cell to change in. In Indian forests we have representatives typical of each of these methods of feeding and pupating.

Hyblæa puera is the well-known teak leaf defoliator. The eggs are laid upon the leaves or twigs of the tree, and the larvæ commence their defoliating operations some time in April (the period of course varies in different parts of India, being later in the drier tracts) and the insect passes through several generations—the number being at times as many as seven—in the year The defoliation is easily recognisable, as the caterpillar in feeding upon the leaf leaves intact the main rib and the side veins, eating all the green leaf tissue between these. They pupate either in rolled-up portions of the leaf itself or on dead leaves upon the ground. The moth is small and dusky in colour, with reddish patches on the hind wings. It is apparently to be found all over India wherever the teak exists, and the larvæ at times entirely strip the teak of their leaves at least twice in the same year.*

The silk cotton-pod caterpillar, *Mudaria cornifrons*, destroys the pods of the silk cotton tree (*Bombax malabaricum*). The eggs are laid in the flower or immature pods of the tree in February-March, according to when the tree flowers; the larva on hatching

* *Vide* Departmental Notes on Insects that affect Forestry, No. 2 p. 287, for a fuller description Also Plate XVIII fig 1; Pl. XIX fig. 1, a,b,c,d; *Injurious Insects*, fig. 71.

out tunnels into the pod and remains feeding in it until the pod falls to the ground. When full-fed the caterpillar bores its way out and burrows into the ground, and constructs the earthen cell typical of the hairless Noctuid larvæ. The grub then changes into the pupal state and passes the rest of the year—hot weather, rains and cold weather—until the succeeding February in this cell. The moth on coming out lays her eggs in the flower or immature fruits of next year's crop.*

The genus *Agrotis* includes the typical earth-living noctuid larvæ, who spend the whole of their larval life in the earth, feeding upon roots, etc. A widely-spread Indian species is *Agrotis ypsilon*, the caterpillars, which are known as "cut worms," occasionally committing great havoc amongst crops. Up to recently it had not been reported as dangerous in the forest, but in 1900 Mr. B. O. Coventry found it eating young deodar seedlings in the Gora Gali nursery near Rawalpindi, and the writer discovered it committing the same damage in some nurseries in the Simla Hills the following year. This larva feeds upon the roots and also comes above ground at nights and in dull, cloudy weather and cuts off young seedlings† close to the soil surface, and either leaves them to die *in situ* or drags some to its hole to feed upon, thus acting much in the same way as the cricket *Brachytrupes achatinus* and the cockchafer grub already described. We at present know very little about the wood-boring noctuids.

FAMILY PYRALIDÆ.

This division must be considered rather as a group of families than as a single one. It includes a very large number of small or moderate-sized moths of fragile structure frequently having long legs; the antennæ are simple, being only in a few cases pectinate. The larvæ are usually nearly bare, with only short scattered hairs and little colouration; they have most varied habits, are fond of concealment, and are very lively and abrupt in their movements, wriggling backwards and forwards when disturbed. They form a cocoon before changing to the pupal state. Species of the family have proved exceedingly destructive to deodar and other cones such as those of the spruce, silver fir, and blue pine. Mr. Ribbentrop, at the time Inspector-General of Forests, noticed that nearly the whole of the crop of deodar cones on trees round Simla were destroyed in 1898 by a larva which proved to be a Pyralid. Recent observations have shown the writer that not only deodar cones but those of the silver fir, spruce and blue pine are infested by one or other or both of two species of the family named *Euzophera cedrella* and *Phycita abietella*, which have apparently much the same life-histories.

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* *Vide* Injurious Insects of Indian Forests, p. 113, fig. 70.

† *Id* p. 113, Plate VIII and Departmental Notes 1, p. 81.

The eggs are laid by the moths some time in autumn either on the flower buds or near them. The exact period at which the larvæ hatch out has not been observed, but they are to be found burrowing in the cones towards the end of May, and continue to do so until about the beginning of August, when they become full fed. The cone by now has become rotten and falls to the ground, and the larvæ will either pupate within it or leave it and burrow into the soil. The moths issue in September and October.

One of the widest known defoliators of the family in India is *Pyrausta machæralis*, which in its larval stage strips the teak of its leaves all over the country, working often in company with *Hyblæa puera*. This insect has as many as seven generations in the year. It spends the winter as a larva in the ground in the Central Provinces, appearing as a moth in May and laying the eggs of the first generation of the year upon the leaves of the tree. As these moths do not all appear exactly at the same time, the egg-laying is spread over several days, and as the eggs laid first hatch out first we have a series of uninterrupted and overlapping generations provided up to November or even December, and one or more of them may produce an enormous number of individuals, the caterpillars stripping the entire crop of leaves from the trees. In feeding these latter do not touch any of the veins of the leaf, but only eat the parenchyma, thus skeletonising it.* Mr. R. S. Hole gives the following as the period approximately spent in passing through a generation :—

From appearance of moth to hatching out of young larvæ laid by it	...	...	7 days.
Larval stage	...	...	16 ,,
Pupal stage	...	...	7 ,,

Or 30 days for a complete generation.

Two other species of Pyralid, *Macalla moncusalis* and *Tetridia caletoralis* have been reported as defoliating sal trees in Ganjam, Madras. The grass moths, small insects which fold their wings tightly round the body and have a head pointed in front, belong here.

FAMILY TORTRICIDÆ.

Moths of small size with a rather large wing area, the wing fringes being never as long as the wings are wide; the hind wings without any pattern in them. The larvæ inhabit their food plant, which may be rolled-up or twisted leaves, or the interior of fruits and herbs, or galls, or even roots. The larvæ have all sixteen legs present. The name *Tortricidæ* refers to the habit the larvæ have of rolling up leaves, or twisting and distorting shoots and buds. Little is known about this family in India.

* For a fuller description see Departmental Notes, No. 2, p. 301. Plate XVIII, fig. 2 ; Pl. XIX, fig. 2 (larva).

Family Tineidæ.

Small moths with the labial palpi more flexible and mobile than in other moths; usually separated and pointed. Hind wings frequently with very long fringes, the wing being reduced in size and pointed at the top. Larvæ are very different in shape and nearly always conceal themselves They feed upon a variety of substances, such as clothes, furs, hair, horns, and seeds, and probably defoliate to a certain extent. They also mine into leaves of trees. Little is known at present about the family, although it probably contains numerous forest pests. The spruce bud binder, *Eucosma* sp. is one of them. The moth lays its egg upon the terminal bud of the spruce branches, probably some time in the summer. The egg remains here until the following spring, and hatches out before the young opening needles of the bud have pushed off the outer cap or covering. The young larva at once spins the tips of the needles together, thus preventing their opening and parting asunder, and thus forms a shelter in which it lives feeding upon the inner and more succulent of the needles. Some weeks are spent in this stage, and the grub then changes to a pupa within the hollowed out bud, and after about 10 days passed in this stage the moth emerges, the external needles of the shelter having by then dried and parted asunder. The writer has seen trees with as many as 70 per cent. to 80 per cent. of the terminal buds treated in this way.

Useful Lepidoptera.

Although Lepidoptera are the most exclusively vegetarian of all the Orders of insects, a certain number of their larvæ prey upon insects which are themselves filled with vegetable juices (such as Coccidæ or scale insects, Aphidæ or plant lice, etc.), and a very small number, such as Tinea, etc., eat animal matter.

In the winged state Lepidoptera may be said to be useful as a whole, since many feed largely upon honey, which they collect from flowers, and in doing this they thus become important agents in the distribution of pollen from flower to flower, as it adheres to their scales and hairs whilst obtaining the honey from the flower.

The Heterocera or moths include several insects which may be said to be of considerable use to man. Amongst them are the silkworm moths of the family Bombycidæ. The mulberry silkworm, *Bombyx mori*, is the cultivated variety in the plains of Bengal, whilst in the forest there are the important Tusser (*Antheræa mylitta*) silkworm of Chota Nagpur and Central and parts of Southern India, the Muga worm (*Antheræa assama*) of Assam and the eri worm (*Antheræa ricini*).

The Noctuidæ contain the genus *Erastria*, the larva of a species of which is predaceous upon a Lecanium scale insect which infests the peach in Southern Europe. It may be found that the forester in India has allies of this nature in the family.

Grass for Paper Manufacture.

REFERRING to G. W. Thompson's letter at p. 80 of your February Number, there was for some time a good deal of uncertainty about the identification of the 'Bhabar' *grass*, and it was very frequently confused with the *sedge* (*Eriophorum comosum*) which is found in similar localities, often mixed with it, and of apparently equal value as a fibre material. The name given by me in my Circar list, *Andropogon involutus*, Stendal, was, if I remember rightly, ascertained at Kew from specimens named by the late General Munro, C.B, the principal authority on grasses of his day. In 1884, 'Bhabar' or 'Bhaib' grass was the subject of a note by Sir W. Thiselton-Dyer, published in Vol. XX, p. 409, of the *Journal* of the Linnæan Society, where the name given is *Pollinia eriopoda*, Hance. In 1888 a figure of the grass was published as Plate 1773 of Hooker's *Icones Plantarum*, the plate being accompanied by a note by Prof. D. Oliver explaining that in the monograph of the Andropogoneæ by Herr E. Hackel, which was about to issue, the name finally adopted would be *Ischæmum angustifolium*, Hackel. The same plate and an account of the grass was also published that year in the *Kew Bulletin*; and later on, in 1893, a full account of it by Mr. E.

Thurston was published in the appendix series of the *Indian Forester*, Vol. XIX. Finally, the full synonymy of the plant is given in Vol. VII, p. 129, of the *Flora of British India*, by Sir Joseph Hooker.

It is only when the plants are not in flower that there is any possibility of confusion between the grass and the sedge, unless the observer is totally ignorant of botanical characters; for their flowers are utterly unlike each other. The *Eriophorum* may be gathered in flower at almost any time, especially in the early cold season, but the *Ischœmum* only flowers, so far as my own observation goes, in the hot season. I believe the leaves, which are the part used for fibre, are of equal value, and I feel sure I have seen two grass-cutters of the Siwaliks cutting these of either species indiscriminately.

The grass and sedge are largely used in paper-making in Northern India, and I will leave the reply to Mr. Thompson's enquiries on the subject of the trade to the many Forest Officers whose information is likely to be more up to date than mine would be.

J. S. GAMBLE.

Sweet Chestnuts in India.

THE sweet chestnut, *Castanea sativa*, grows well at Dehra Dun and on the slopes of the Himalayas above 2 000 feet. This tree is calciphobous and will not grow in a soil containing more than 4 per cent. of lime. Its fruit is sold in the Dehra Dun bazaar, and forms an excellent article of food, from which cakes and puddings are made. But the fruit produced in India is small, being only that of the forest tree and not of the varieties improved by cultivation, which are grown in the South of France, Spain, Italy and other Mediterranean countries. There would therefore be much advantage to India if the better varieties of sweet chestnut were imported and grown in suitable localities. In these varieties the large size of the fruit is said by Sir W. Thiselton-Dyer to depend on selection, only one or two ovules being developed in each involucre in the better varieties, the rest being suppressed. Such varieties as the *Marion de Lyons* and the *Gros Merle* are grown in Kew Gardens and produce fruit, and some years ago a sack of good chestnuts were sent to Covent Garden from Gloucestershire and fetched £3, the fruit coming in earlier than imported fruit. Mathieu, in *Flore Forestière*, says that most of the large fruited chestnuts in France are grown by grafting on the common stock. In Corsica, meal is ground from the dried fruit and forms *pollenta*, an important article of food used by the peasants. These large fruited varieties are very liable to injury from late frosts, and when they were introduced into Alsace, where much chestnut coppice is grown for vine-props, the large fruited varieties were frozen down annually to the stool. They are very subject to this injury at Kew, but could easily be grown in warm places in the

west of England and in Ireland. Certainly in warm situations, on soil which does not contain too much lime, above 2000 feet altitude, in the Himalayas, the climate is sufficiently like that of the South of France, for the large fruited chestnuts to thrive and form a great addition to the food of India. Sir W. Thiselton-Dyer has also informed me that there is a difficulty about keeping the fruit, and that in India it will not keep for more than a few weeks, but it is kiln-dried in Italy and will then keep indefinitely. Kew would certainly arrange to supply the Indian Government with plants if application was made.

W. R. FISHER.

[In December 1900, 375 seedling and 50 grafted dwarf chestnut plants, ordered by the Secretary of State, were received from Messrs. James Veitch and Sons, Ld., and planted out in the Chakrata Forest Garden and in the Malon nursery near Kathian, where most of them are doing well. A similar consignment, it is believed, was sent to Kulu —HON. ED.

Forest Destruction by Insects in Norway.

THE extract under this heading from *The Timber Trades Journal*, which appeared in the March number of this magazine, should be widely read by, and receive the serious consideration of, all interested in the up-keep and well-being of the forests of, India; and its application need not be limited to coniferous forests only.

In the extract in question we read that the great forests in Osterdalen and Solar in Norway are suffering from a fearful plague of caterpillars, which are stripping the pine trees bare, and that already the estimated damage has reached the figure of 300,000 kroner (over £15,000), whilst the value of the threatened areas is estimated at 1,200,000 kroner (over £60,000). The attack is considered to be as yet only in its initial stages!

But the pest—and this is where the lesson should strike home to us in India—is well known, its annual life-history has been well studied and is understood by the most illiterate of the forest hands; the previous severe attacks experienced from it are all on record, and consequently the districts affected are up in arms as a whole and are banding together and devising means whereby the young larvæ are to be attacked simultaneously in the spring, when they reappear after their winter hibernation and endeavour to mount the pine trees to continue their depredations. The details of the life-history being common knowledge, it is known where the caterpillars are hibernating and when and how they will re-appear. The Agricultural Department have been asked for a grant of 25,000 kroner (nearly £1700), which is being employed in preliminary enquiries as to how the pest can be best destroyed.

I would ask—What would our position be in this country in face of a misfortune of this nature? Such an attack would probably occur on a scale so colossal, owing to the greater vastness of our forest charges, as to make the gravity of the Norway infestation, serious as it is, appear insignificant beside it. Even were the

attack to last several years (it is considered this Norway one will last three unless the caterpillars can be killed off) it would be too late for us to do much more than watch it and thus to learn by bitter experience the life-history of the pest and perhaps how to do better next time. Knowing nothing of the life-history, we should have to start at the commencement and study this whilst the destruction in the forests was perhaps running into lakhs and crores of rupees. In all probability we should not be able to say where the pest would hibernate, or when and how it would reappear in the following year, nor how many life cycles we had to expect, to fight in the year. Further, it is more than probable that we should know nothing about any of its parasitic or predaceous enemies. We should have to learn all this whilst the damage was being done. These are not the mere illusory or fanciful statements of the alarmist. The world has furnished numerous instances of such inflictions. This Norway attack but adds one more to the lengthening list.

In India our forests were natural virgin ones when the Department started work, and as such consisted of trees of all ages and, in many instances, of very different species. In such Nature holds the scales and keeps even the balance of power between the trees and the insects which prey upon them. When the forester appears he alters all this. He wishes his forests to contain valuable species of trees packed as close together on the ground as possible. He accordingly takes the virgin forest in hand, cuts out all dead timber and badly formed and mature trees, and encourages the growth of more valuable species. Thus large tracts of forest soon approximate to a more nearly even age and the growth assumes a more similar character, the valuable species being encouraged to grow together, where possible, in large masses. Further, he forms plantations in which large blocks of the trees are naturally of the same age and ofttimes of the same species; he clear cuts other areas and gets up even-aged coppice, or sows seed wholesale over the tract felled and produces an even-aged young forest consisting of often but one or two species of tree.

In all such operations the forester is helping the insect pest against the tree by affording it every facility in its growing stage of life of (1) finding a large amount of its favourite food material ready to hand; (2) enabling it to move easily and quickly about over this, since the tree next to the one upon which it is feeding is of the same species. The insect has not, therefore, to undertake perilous journeys, during which it is at the mercy of birds and predaceous insect foes, to search for a fresh host. Given one or two dry seasons, which will be favourable to the insect, and enormous plagues of it appear, following an ordinary law of Nature. That the Department in India will in the future have to meet such plagues and fight them is as absolutely certain as the fact that there are such laws to be obeyed, and I ask again—

What shall we be capable of doing? It will be of little use going to Europe or America for parallel cases. The life-histories of our pests in India, or what is known of some, show that they differ from those of closely-allied European or American confrères, and what therefore may be a good remedy there will probably be useless in India and may even do much harm.

To the thoughtful there can be little doubt that the present is the time to work out the life-histories of our forest insects, any and every one met with, for we know not which is to prove the pest of the future. This work should move hand in hand with the amelioration of the forests—amelioration, that is, from the forester's and commercial point of view, and which has become essential owing to the necessities of the growing population of the world, which demands and will have a high outturn per acre of the crop growing upon it. It is therefore necessary that we should be in a position to fight the insects which dispute with us the possession of our crop. In Europe every Forest Officer has an acquaintance with the insect pests he may have to fight. The knowledge is as essential to him as his sylvicultural knowledge, for large sums of money may depend upon his possessing it and being able to apply it promptly.

I do not mean by this that all European Forest Officers are Entomologists. They are not so any more than they are wood-cutters because they know how to fell a tree, clerks because they understand how to keep accounts, or learned pleaders because they may have to conduct cases in court. But they have a working knowledge of the chief insect pests whose attacks are to be feared.

Unfortunately in this country such knowledge is not at present available for general information, for it has yet to be culled from Nature's handbook, but I would point out that in such a vast continent as India every Forest Officer should help in these observations and endeavour to learn something about the insect life of his own forests. We shall thus arrive more quickly at the knowledge of which are and which are not the insects most to be feared in particular forests. That the day will surely come to some, whether in charge of a circle, a division, a range, or a beat, when such knowledge may be the means of saving, by their being able to take immediate action (this means everything in such attacks), large areas of the valuable forests entrusted to their charge, is only too probable. Our endeavour in India should therefore be to get ready by studying the life-histories of the insects we meet. This is the first step. It is useless talking about the possibility of remedial measures until we know what our enemies' tactics are and where they are to be found at the different seasons.

INDIAN MUSEUM,
March 11th, 1903.

E. P. STEBBING.

The Harcourt Working-plan.

ALL readers of the *Indian Forester* who are interested in the intricate problems presented by the treatment of high forest in this country, must be grateful to Mr. Gleadow for occasionally letting in gleams of French sunlight on the darkness which surrounds us. On a former occasion we benefited by a highly interesting, though somewhat barren, discussion on "Proportionate Fellings," and in the March number of this year Mr. Gleadow presents to us another method of ascertaining the possibility in high forest. However, the chief interest of the article entitled "The Harcourt Working-plan" lies in Mr. Gleadow's footnote rather than in the article itself. The note is rich with suggestion, yet commits the translator to nothing, and the question at once arises—Which part of the working-plan does he consider to be "not without its bearing on the treatment of high forest in general?" Presuming that we are dealing with a forest which is already high forest, it would appear that the method of calculating the possibility and executing the fellings in the high forest, is alone of interest. The latter bears a strong resemblance to the prescriptions for the improvement fellings which are being carried out in many sal forests, while the former is remarkable for being the very opposite of the method formerly advocated by Mr. Gleadow under the title of "Proportionate Fellings." One of the advantages of that method was that it obviated all necessity for any "clawings and scratchings," but now we are invited to measure every tree over 24 inches girth before felling. This is certainly a new idea as regards the treatment of Indian forests, and it is likely to remain so; but intrinsically it seems a notion of great antiquity, for it must have been obvious to the first man who ever proposed to make fellings which should keep the volume of timber on the ground a constant quantity, that the best way to do it is to ascertain accurately what you have got to start with. The difficulty as usual is to do it, except over a very small area.

BAHRAICH, 7*th March* 1903. F. F. R. CHANNER.

Manual of Indian Timbers.

THE long expected revised edition of Mr. Gamble's *Manual of Indian Timbers*, available for sale is valued 18*s.* per volume. It means Rs. 13-8-0, exclusive of postage, etc.

It is hardly necessary to point out that every native forest officer will wish to possess such a valuable book, but the price is prohibitive considering the emoluments of the native forest officers of the Madras Presidency.

I would respectfully suggest that Government will be pleased to arrange to have it sold at a reduced rate to forest officers whose salary is Rs. 200 per mensem or less, as was done

in the case of some publications, such as Board's Standing Orders, Treatise on Family Medicine, etc.

SOUTH CANARA, *3rd January* 1903. S. KUBHUSWAMY CHETTIER.

Forest Administration in the N.-W. Frontier Province during 1901-02.

THE forests of the Frontier Province are comprised in the former Hazara Division of the Punjab, and the Administration Report for the year contains little which calls for especial notice in these columns. Mr. A. V. Monro, Deputy Conservator of Forests, is in charge of the forests, and the exact procedure in connection with the forest administration of the Province has not yet been settled. There are roughly 234 square miles of reserved forest and 131 square miles of protected forest in charge of the Department, no alterations of any importance having taken place during the year.

Arrangements have been made to commence a detailed survey of the forests on the 4-inch scale in place of the mere boundary survey originally proposed, and this is undoubtedly a wise step, which will be of great value in connection with the future working of the forests.

No progress is being made at present with the preparation of working-plans, owing mainly to the fact that at present the supply of forest produce greatly exceeds the demand. A working-plan does exist for the Upper Kagan forests, and with regard to various other forests enumeration surveys have been made and statistics compiled in preparation for the time when, owing to increase in the demand, it will become advisable to place the other areas under a systematic plan.

Forest offences were fairly frequent: thirty cases were prosecuted and 455 compounded during the year; the most common offence was illicit grazing, which would appear to require to be more severely dealt with in future years.

Fire overran only 3538 acres of fire-protected forest, while 42,295 acres were successfully protected, the cost of the protective measures amounting to Rs.763, all of which was spent on the employment of fire guards.

Measures for the improvement of forest growth consisted mainly of sowing, transplanting and tending of seedlings. Much attention was given to felling and girdling pines over deodar, 15,000 acres of forest being systematically gone over for this purpose. It is still a matter of opinion whether this really does much good, and whether deodar if left alone will not succeed in

struggling up through the not very dense cover given by blue pine.

Most of the major produce was removed by Selection fellings, but an attempt was made in the Khanpur forest to introduce the system of coppicing instead of restricting the removals to dry wood.

The financial results of the year's working are not very satisfactory. A deficit of Rs.8325 on a total expenditure of Rs.46,000 calls for rigid economy in the management of the forests, until an increased demand justifies the incurring of a larger expenditure on works of improvement.

Forest Administration Report of Burma for the year 1901-02.

IN their modern form Forest Administration Reports, which are cut down to bare statements of progress in matters of routine, do not offer such interesting material for reading as formerly.

The report on forest administration in Burma during the past year shows, however, that in spite of (from a revenue point of view) an exceptionally bad year, steady and strenuous advances were made in this young and promising province, which already contributes more than half of the surplus forest revenue of the whole of India, although customarily spoken of as hopelessly backward and slack compared with some of the "model" provinces of Northern India.

The constitution of the natural wealth of the country into permanent forest estates is a work which will not be completed for a long time, owing to the vast areas to deal with, and the necessarily gradual development of the country. During the year under report nearly a thousand square miles of forest were added to the reserved forests, making a total of 18,606 square miles altogether.

The hitches which occurred in the settlement of some of the new reserves may very well be accounted for, we think, by the fatally frequent transfers of Divisional Officers. No Forest Officer who has spent three or four years continuously in one division, and has pushed forward the preliminary work connected with the selection of new tracts for reservation and for their settlement, can be so devoid of any personal interest in the matter as to occasion the miscarriage of the settlement.

Demarcation and survey operations were carried out conformably with the extension of the areas under reservation and the practical requirements of the working of the forests. In the older part of the province new detailed surveys of nearly 100 square miles of reserves were made, and in Upper Burma the Forest Survey Department mapped about 875 square miles of reserved forest.

As regards working-plans, very little progress was made, except in the Pyinmana and Shwegyin divisions. The insufficiency of the number of qualified officers, and the constant changes that consequently take place, have seriously interfered with this work. Provided that a sufficient staff of officers is available, the Government has now drawn up a five years' programme, providing for eight working-plans parties, two in each circle. Good results should follow from this plan so long as the under-manning of the staff does not render it impracticable.

The results of fire-protection showed some improvement, though there is still a good deal to be desired in this respect.

In Burma the difficulties and hardships connected with fire-protection are considerably greater than in other provinces, but the results, even when every allowance has been made for this condition of things, cannot be considered as satisfactory.

We believe that Sir Frederick Fryer has hit the right nail on the head in attributing the backwardness of Burma in the matter of fire conservancy to want of sufficient personal supervision by superior officers.

In this connection a paragraph in the Annual Report of the Southern Circle, Upper Burma, is significant. It is there stated that a Deputy Conservator of considerable experience openly declares that fire-protection in teak forests is a mistake, and proposes to periodically fire his forests for several years in succession! The observations on which this revolutionary doctrine is based are true enough, but it is hardly possible to believe that the temporary retardation of natural reproduction, which often results from fire-protection, is not more than compensated for by the advantages obtained by the exclusion of fire from the forests, not only for the soil and vegetation generally, but also for the young teak growth itself.

Under the heading of natural reproduction some interesting information is given with regard to experiments which are being carried out in parts of Bhamo and Katha, where natural reproduction offers serious difficulties.

In Bhamo the simple expedients of fire-protection and cutting back, and in Katha the equally simple operation of raising the cover and clearing the ground under old teak seed-bearers, have been resorted to.

In Pyinmana the Conservator reports that the Divisional Officer absolutely refuses to extend teak plantations in spite of all orders and working-plans which prescribe them.

The planting of teak *taungyas* requires to be done with discretion, and only in places suitable for it, but for the last thirty years the greatest success has attended the extension of teak *taungyas* in Burma, and the Lieutenant-Governor's regret that the present generation of Forest Officers in parts of the province are disinclined to make any advance in this important work is easily understood.

A single paragraph in the report disposes of the forest garden and plantations at Maymyo. Further details of this interesting work would be worth recording, and it is hoped that now that the ground is to be systematically planted, more information will in future be given with regard to the measures taken for stocking the plantations and the success that they obtain.

The year under report was a bad one for floating, and the quantity of timber extracted was comparatively small in consequence.

Over three million cubic feet of teak were extracted departmentally, and over 5¼ million feet by lessees and purchasers.

Including free grants, the outturn of the year was 8½ million cubic feet, and fourteen million cubic feet of other kinds of timber. The average price realized at Government sales of teak during the year was Rs.61 per ton, and the average price per ton of teak timber exported from the country was nearly Rs.86.

Under the heading of minor produce it is stated that the forests of *Ficus elastica* in unadministered tracts in the extreme north of the province are being rapidly devastated, and that no effective measures can be taken to protect them. The revenue from rubber is 83 per cent less than it was last year, and that again was 60 per cent. less than that of the year before.

The financial results of the year's working show Rs.59,51,334 and Rs.28,20,311 as the receipts and charges respectively.

The surplus is therefore Rs.31,31,023, or 53 per cent. of the gross revenue.

The surplus for the previous year was over 50½ lakhs, and the decrease in revenue is explained by an abnormally bad floating season, resulting in a decrease of over 5 lakhs to the revenue derived from departmental workings, and of nearly 11 lakhs to revenue paid by lessees.

We are glad to notice in conclusion that the constant trouble caused by the collection of botanical specimens and economic products has been officially recognised, and that it is proposed to detail a special officer for this work. This is certainly a step in the right direction.

V.—SHIKAR AND TRAVEL.

The Indian Pheasants and their Allies.

By F. Finn, B.A., F.Z.S.

(*Continued from page* 122.)

Chapter VI.

PARTRIDGES.

With the fire-back discussed in the last chapter the series of pheasants comes to an end, and we enter on the consideration of the various partridges. These are, as was said in the Introduction, short-tailed birds, usually much smaller than pheasants. They fall into several very natural generic groups, some containing only one Indian species each. There is some difficulty for the beginner in making them out, for the males are generally plain and much like the females, and do not present those striking characteristics which make the various cock pheasants referable to their proper genera at once. But with a little trouble partridges are not more difficult to correctly identify than are hen pheasants.

Taking as partridges all the short-tailed game birds with a wing over five inches long—under that size they rank as quails—we find that they may again be subdivided, as were the pheasants, by the length of tail. All partridges have rather short tails, but in some the tail is *very* short and not a very noticeable feature.

Among the longer-tailed partridges, in which the tail is more than half the length of the closed wing, we find the Ramchukors or Snow-cocks, the Snow-partridge, the Bamboo-partridge, the Spur-fowls, the Chukor, the Tibetan partridge, and the Francolins. Of these:—

The *Ramchukors* (two species) are easily distinguished by their great size, being a foot-and-a-half long, and bulkier than an ordinary fowl. No other partridge exceeds fifteen inches.

The *Snow-partridge* is at once recognisable by having the front of the shanks feathered half-way down, the only other Indian game bird with this peculiarity being the very easily distinguishable Monauls.

The *Bamboo-partridge* has a particularly long tail, only about an inch shorter than the wing. [By some slip or other I said in the Introduction that this partridge's tail was *longer* than the wing; but this is of course not the case.]

The *Spur-fowls* (three species) have equally long tails, but their eyes are surrounded by a bare skin, unlike those of the Bamboo-partridges.

The *Chukor* is easily recognisable by its plain drab upper surface.

The *Tibetan partridge* by the black patch in the middle of its breast.

The *Francolins* (five species) include all the other medium-tailed partridges. They may be known by having no striking points, so to speak; no particular length of tail, no bare skin round the eye or feathering on the shanks; their backs are never plain drab, nor have they a conspicuous black patch on the breast.

To the section of partridges with *very* short tails belong the hill partridges, the Green-legged partridge, the Red Wood-partridge, the Crested partridge and the Seesee, distinguished *as follows:—*

The *Hill partridges* (six species) by their remarkably long nails.

The *Green-legged partridge* by a peculiar patch of white downy feathers under the wing, just behind the armpit.

The *Red Wood-partridge* by being mostly of a chestnut colour.

The *Crested partridge* by the male being dark blue and the female green.

The *Seesee* by its sandy colour and pale yellow legs.

In the present chapter I propose to deal briefly with the Alpine Ramchukors and Snow-partridge, the Chukor, and the desert-haunting Seesee. These rarely go into cover, and so do not really concern Forest Officers in the ordinary way. But for the sake of completeness it is as well to include them; besides, some of my readers may go shooting in their treeless haunts when on leave, and then make their acquaintance.

The Ramchukors or Snow-cocks are very large grey birds, living on the mountains above the forest-level, and feeding on grass chiefly—there is not much else to eat where they are found. Two species are found with us. The cocks and hens are alike in plumage, but the former alone are spurred.

The Himalayan Ramchukor.

Tetraogallus himalayensis, Blanford, Faun. Brit. Ind., Birds, Vol. IV, p. 143.

Native names :—*Kullu, Lupu, Baera,* in Western Nepaul; *Huinwal* in Kumaun; *Jermonal,* in the hills north of Mussoorie; *Leepin,* Kulu; *Galound* in Chamba; *Gourkagu* or *Kubuk,* in Kashmir; *Kabk-i-dara* in Afghanistan. The name *Ramchukor* is, I believe, used in Gilgit. It is certainly the best one for these birds, which are really gigantic relatives of the Chukor. The European names of Snow-cock and Snow-pheasant are unmeaning, as the bird is obviously a big partridge, not a pheasant or jungle-fowl.

The general colour of this bird is grizzled grey with some chestnut markings; the throat is white with a chestnut border and the breast white with some black bars, the pinion quills are white with broad black tips. The bill is horn colour, the feet orange, and the eyes dark, with a patch of bare yellow skin behind them. The hen is easily distinguishable from the cock by her much smaller size; she is about two inches under two feet long, while he exceeds that length by about two inches. Young birds show some brown mottling on the forehead which is not present in old ones.

This noble partridge is found from Afghanistan and Central Asia all along the Himalayas as far Kumaon. According to season it is found at from 18,000 to 7000 feet elevation, keeping usually in flocks, which frequent open rocky ground. It breeds high up, from May to July, usually laying five eggs, drab with reddish brown spots, and reaching nearly three inches in length. The golden eagle appears to spend a good deal of its time in trying to catch these birds, without very much success; for they are very wideawake, and the human hunter finds a rifle the best weapon with which to come to terms with them. And then when they are brought to bag they are not good eating according to European tastes, although natives are glad enough to get them. The call of this bird is a whistle, which it keeps uttering all the while it flies.

THE TIBETAN RAMCHUKOR.

Tetraogallus tibetanus, Blanford, Faun. Brit. Ind., Birds, Vol. IV, page 144.

Native names:—*Hrak-pa*, Bhutias in Sikkim.

This bird bears a general resemblance to the last, but is considerably smaller; it has no chestnut about the neck, and the breast is devoid of black markings, but crossed by a broad grey band. The most striking differences, however, are that the underparts are streaked with black and white instead of being grey, and that the pinion quills are brown with white tips. The cock and hen do not differ much in size in this species, and even the former is smaller than the hen of the Himalayan bird. The cock's bill and legs are red, and there is a red skin round the dark eyes. The hen's bill, however, is of a greenish colour, though she appears not to differ otherwise in colour. Young birds, however, have only the throat white, the breast being grizzled with dark-grey and buff.

This species is properly a Tibetan bird, but in our territory it has been found in Ladak, Spiti, Kumaun and Sikkim, always at a very high elevation, being an even more alpine bird than the last. All that is known about its breeding is that its egg is like that of the Himalayan species, but smaller. It appears to be a much better bird for the table.

THE SNOW-PARTRIDGE.

Lerwa nivicola, Blanford, Faun. Brit. Ind., Birds, Vol. IV, page 145.

Native names:—*Lerwa*, Bhutia; *Janguria*, Kumaun; *Quoirmonal*, Garhwal; *Golabi*, *Bhair*, *Ter Titar*, Bashanr, etc.; *Burf ka Titar*, Kulu; *Biju* Chamba.

This is a much smaller bird than the Ramchukors, and in appearance and habits much recalls a Ptarmigan. The cock and hen are alike in plumage, but the former is distinguished by possessing spurs.

The head, neck and upper plumage generally are closely barred with black and white, the latter colour running into buff in places; the under parts are mostly of a dark chestnut. This rich plumage is well set off by the red beak and legs. The eyes are dark. Young birds are less distinctly barred and are mottled with black below. The length is about fifteen inches, with a wing of nearly eight, tail four-and-a-half, bill nearly one, and shank half an inch longer.

The Snow-partridge inhabits the Himalayas from Kashmir to Sikkim, and extends to Moupin and Western China. It is locally distributed with us, and is usually found at very high elevations, close up to the snow, among stones and stunted herbage. Its usual elevation is about 11,000 feet, though in winter it may come down as low as 7000. It goes in pairs in the breeding season, and its chicks have been found late in June. Later on it is found in coveys, and affords excellent sport; it is also remarkably good to eat. But as it is commonly found on the same ground as Burrhel and Tahr, it is usually neglected by sportsmen for the nobler game.

THE TIBETAN PARTRIDGE.

Perdix hodgsoniæ, Blanford, Faun. Brit Ind., Birds, Vol. IV, page 142.

Native names:—*Sakpha*, Tibetan.

This partridge bears a strong resemblance to the common partridge at home, and is indeed nearly related to it: the cock and hen are alike, and neither of them possesses spurs. The plumage is an intricate mixture of buff, black and chestnut, with the throat white and neck chestnut; the underparts are barred with black, which colour forms a patch in the centre, and there is a black patch on each cheek; the bill and legs are of a dirty green, and there is some reddish skin round the eye.

This bird is about a foot long, with a wing of six inches.

The species is properly speaking a native of Tibet, but it has strayed into our territories, one having been got by Mr. Wilson

in the Bhagirathi valley, when shooting chukor in the autumn of 1841. It appears to be a bird of very high elevations. Its eggs have been taken in Tibet in July; they were ten in number, and of a pale drab tint without spots.

THE CHUKOR.

Caccabis chucar, Blanford, Faun. Brit. Ind., Birds, Vol. IV, p. 131.

Native names:—*Chukar*, Hind; *Kabk*, P.; *Kau-kau*, Kashmir; *Chukru*, Chamba.

The chukor is one of the group of red-legged partridges to which the well-known "French partridge" (*Caccabis rupa*) belongs, and much resembles that bird. The cock and hen are alike in plumage, but the former may be distinguished by having a knob or blunt spur on each leg.

The plumage above and on the breast is of a plain grey without any markings, with a tinge of reddish in places and sometimes verging on olive brown; the throat is white or buff, surrounded by a black band. The lower parts below the breast are buff, and the flanks very beautifully banded vertically with grey, buff, black and chestnut. The bill, legs and eyelids are red, and the eyes themselves dark or orange.

The cock, which is a little larger then the hen, is about fifteen inches long, with the wing six inches and-a-half, tail just over four, shank nearly two, and bill just over one.

The chukor has a very wide range, from Greece to China. It is a lover of open hilly ground, and with us is found on the Himalayas, in the hilly parts of the Punjab and in the higher hills of Sind west of the Indus. According to the country it inhabits, it is found from the sea-level up to 12,000 feet, and in Tibet even to 16,000. Himalayan birds are darker and browner in in tint, but in Ladak, the Western Punjab, and Sind—in dry open tracts, in fact—are paler and greyer. The birds haunt open hill-sides among grass and scattered bushes, but may also be found in more or less wooded country and in cultivation. In winter they go in coveys or even flocks, but in the breeding season in pairs. The said season is from April to August, varying according to the elevation; for birds at high levels of course breed later. The eggs are up to a dozen, cream-colour with brown or lilac spots. The chukor is a noisy bird, and its two syllabled note has given origin to its name. It is a fairly good sporting bird, but not so good to eat as some other partridges. The ancient Greeks, judging from a passage in Xenophon, appear to have been in the habit of riding it down, a sport which is still practised in Yarkand. Chasing partridges to kill them with a whip does not sound very sportsmanlike, but the awful ground over which the flying covey is

pursued requires the sure-footed Yarkand pony to negotiate it properly, and thus introduces a pleasing element of uncertainty which redeems the sport from the imputation of poaching.

The chukor is a good bird for introduction abroad where partridges are required, as its adaptable constitution makes it bear captivity well. It was tried in New Zealand, and bade fair to succeed, but the birds were not sufficiently protected, and were all shot off almost at once. It would hardly be worth while to turn it out in England, as we have already the very similar red-legged partridge there. Indeed, I have been asked whether the two were not identical. But the red-leg or "Frenchman" at home is a brown-backed bird, not greyish, and has a number of black spots bordering the black necklace outside, and thus is easily distinguishable from the chukor.

THE SEESEE.

Ammoperdix bonhami, Blanford, Faun. Brit. Ind., Birds, Vol. IV, p. 133.

Native names:—*Sisi*, Punjab and Sind; *Tihu*, P.

This is a short-tailed little desert partridge, with plumage beautifully adapted to conceal it in its natural haunts. The cock and hen differ somewhat in colour, but neither has any spurs.

The cock is of a grizzled sandy hue above, with a grey head and fore-neck, and the under parts below this pinky buff. There is a black streak along each side of the head with a white one under it, and the flanks streaked with black and chestnut.

The hen has no black and white markings on the head nor chestnut on the flanks; the lower plumage is barred with brown and buff.

The bill is orange, the eyes yellow or brown, and the legs yellow. The cock, which is rather larger than the hen, is ten inches long, with a wing of five-and-a-half. The Seesee inhabits hilly deserts, avoiding cover, though it may be found on grassy slopes. In India it inhabits the Salt Range and Khariar Hills in the Punjab, Hazara, and all the Sind and Punjab ranges west of the Indus. It is also found in Baluchistan, Afghanistan and Persia; and has been reported from Aden.

It has a soft clear double note, recalling its name; and is not usually gregarious, though small coveys may be found in winter.

The breeding season is from April to June, and as with the chukor, the eggs may be as many as twelve in number, but they are creamy-white in colour without any spots. As an article of food the Seesee varies somewhat; it is not much of a runner, and when it wants to conceal itself has only to sit still, its plumage being its best safeguard against detection by its enemies.

Analysis of Soils in Sal Forests.

Analysis of Samples of Soils from the Dholkot (Sal) Forest in the Dehra Dun District.

Sample No.	Total nitrogen.	Available phosphoric acid.	Total phosphoric acid.	Calcium carbonate.
Sample 1. Surface soil from an open glade surrounded by seed-bearing sal trees, but without any reproduction.	0·043	0·026	0·105	0·187
Sample 2. Surface soil from a similar locality, but with young growth of medium quality.	0·101	0·028	0·112	0·293
Sample 3. Surface soil from under a very thick growth of young sal trees about 25ft. high.	0·152	0·048	0·144	0·685

Dr. Leather, who made the analysis in 1897, remarks that the soil from sample 3 is the richest and No. 1 the poorest in plant food, which probably explains the absence of reproduction in the latter.

The Insect World in an Indian Forest and how to Study It.

BY E. P. STEBBING, F.L.S., F.E.S.

Continued from page 186.

PART VII.

THE ORDER *DIPTERA*.

THE *Diptera* comprise the two-winged flies, including also the fleas, which are wingless, and the parasitic wingless insects such as the sheep ticks. The exceptions to the general two-winged rule in this Order are very few, although there are some 40,000 species known and an enormous number still unknown.

The Order has never been a popular one either amongst entomologists or with the general public. The scavenger-like habits of some and the annoyance caused by others have rendered the insects unpopular and caused their study to be neglected, nevertheless they may perhaps be classed as actually the highest insects physiologically, for in them the processes of a complete life-history are carried on with the greatest rapidity. A maggot hatching from the egg is able to grow with such rapidity that the work of its life in this respect is completed in a few days; then forming an impenetrable skin it dissolves itself almost completely; it then solidifies to a sort of jelly, and in a few days reconstructs itself as a being of totally different appearance and habits.

The wings of flies are usually transparent and never very large; they have a small piece attached to their lower inner angle called the 'alula'; behind the wings there is situated a pair of small erect capitate bodies called the halteres, which are often concealed under membranous hoods and are used for balancing purposes. There is no distinct prothorax present, the thorax being an immovable mass. The head is very mobile and is connected with the thorax by a slender concealed neck. A large part of the head is occupied by the big compound eyes, which are usually larger in the male than in the female. The antennæ vary in structure, and are of importance as we shall see, the classification of the Order being based upon them. In some a long jointed antenna which may be whorled is present. The majority of flies have, however, an antenna peculiar to the Order, consisting of three segments, the outer one of which is of diverse form and bears upon its front a fine projecting bristle, frequently feathered and often distinctly divided into two or more joints. This form of antenna is found in the series *Aschiza* and *Schizophora* and is present in the common house fly. In the Order generally the two basal joints of the antennæ are called the 'scape;' the part beyond this is called the 'flagellum,' an appendage of the flagellum being termed the 'arista' if bristle-like, or if thicker the 'style.' The mouth parts are formed for suction and consist of a sucking tube of varying form which sometimes ends in a flat pad as seen in the common house fly. The legs are long and slender and terminate in claws with one or more pads between them, which are covered with a sticky fluid which enables the insect to walk on glass surfaces, etc. The abdomen is conical and usually sessile. The larvæ are invariably maggots, *i.e.*, they are legless. Some, however, still possess a hard chitinised head furnished with eyes, antennæ and mouth parts. In others the head is not well marked, eyes are absent, antennæ absent and mouth parts represented by a pair of darkly coloured chitinous hooks. On account of the presence of such weak mouth parts the grub feeds upon decaying filth and refuse and other soft matters.

In those *Diptera* whose larvæ have well developed heads the pupæ are like those of the *Lepidoptera*, the appendages lying close

to the body; in those with 'headless' grubs the pupæ remain within the last hardened larval skin, and the pupa is then called 'coarctate.' In these latter no appendages whatsoever are to be seen on the outside, the chrysalis being generally blunt ovate in form.

The *Diptera* are divided according to the nature of the antennæ present into five great series, a few families of each of which will be considered below. Although members of the Order have not as yet been reported as committing much damage in Indian forests, it is not unlikely that we shall find, as our knowledge increases, that the gall-making ones are of considerable importance. It may be mentioned here that the teak trees in the Melghat forest in Berar are badly attacked by a dipterous gall-making fly. Under its attack the branches swell up into rounded lumps, which sometimes completely encircle them, and these are at times so numerous as to distort the branch with irregularly-shaped swellings for some inches up, the galls often coalescing. It would appear that when the gall completely encircles a branch or leading shoot of a young sapling the portion above it dies. The writer bred out two of these flies from galls at the end of July in the Melghat, but unfortunately they got injured in transit home and their identification was impossible. Teak in Madras, especially young plants, would appear to be affected in a similar way, but the writer has not been able to procure any mature specimens of the insect in spite of several attempts which the Conservator of Forests in Mysore has kindly made to obtain them for him. There can be little doubt that the pest is capable of committing considerable havoc.

The habit of blood-sucking from vertebrates is, among insects, of course confined to those with a suctorial mouth, and is exhibited by various *Diptera*. It is however indulged in by but a small number of species, and these do not belong to any special division of the Order. The habit is as a rule confined to the female sex, and a large proportion of the species with this propensity have aquatic larvæ.

Series I.—Orthorrapha Nemocera.

Antennæ consist of more than six segments and are not terminated by an arista. Palpi slender and flexible, four or five-jointed.

Family Cecidomyidæ (Gall Flies).

An extensive family of very minute and fragile flies, the wings* of which are provided with only a few nervures; the antennæ are rather long and are furnished with whorls of hair upon them. In some species the antennæ are beautiful objects when seen under a magnifying gass. The larvæ are of importance as their habits are very diverse. They are short maggots, narrowed at either extremity, with a small head and 13

segments. The majority live in plants and form galls or produce deformations of the leaves, stems, flowers, buds and roots in many ways. Others live under bark, whilst others are predaceous, feeding upon *Aphidæ* or *Acari* or even other *Cecidomyiidæ* The larva of an India species (*Cecidomya oryzæ*) have proved very dangerous to rice, feeding in the stalk and killing off the plant. The insect known as the Hessian fly, *Cecidomyia. destructor*, of Europe and America, is frequently excessively injurious to crops of cereals, committing at times the most serious depredations.

FAMILY CULICIDÆ (MOSQUITOES, GNATS).

Slender insects with very long legs, the antennæ being provided with whorls of hair or plumes on them, generally very long and dense in the male. The head is furnished with a long projecting proboscis. The larvæ live in stagnant water. They have a largely developed head and thorax, and so can be distinguished form other dipterous larvæ. The pupæ also live in water and move about in it.

Much has recently been written on the genera *Anopheles* and *Culex*, and it has been practically proved that species of the former can induce malarial fever in man. The larvæ live in water, floating flat upon the surface. The perfect insect is the well-known mosquito. The life-history is as follows*:—

The eggs are deposited on the surface of the water, where they float in raft-like masses. They hatch in a very short time, generally—in warm climates—within 24 hours, giving rise to small wriggling worm-like creatures, which feed either on minute water plants or on decaying organic matter. They breathe air, and must repeatedly come to the surface for that purpose. Their mouths are provided with a pair of brush-like organs which they keep in rapid motion, producing a miniature vortex which draws floating particles within reach of their jaws. After a period varying from 7 to 15 days, during which time they undergo some four or five moults they assume the pupal stage, when their form is again changed. They now appear something like minute tadpoles or—still more—like animated commas, with a globular anterior portion and a thin-curved tail. They take no food in this stage, but are very active, progressing through the water with a wriggling motion. Their breathing organs are now transferred to the front of their bodies and appear as small ear-like structures, and the insect rests in a more or less erect position, head upwards. In about three days' time the skin of the back splits and the mature mosquito emerges, resting upon the empty skin of the pupa, as upon a raft, until its wings are firm and dry, when it flies off.

* *Vide* Royal Botanic Gardens, Ceylon, Circ. Ser. I, No. 25, "Mosquitoes and Malaria." E. E. Green.

The differences between *Culex* and *Anopheles* are well marked and may be shown as follows:—

Culex.	*Anopheles.*
Eggs: agglutinated into raft-like masses on the surface of the water. Each egg p'aced vertically.	*Eggs:* separate, floating horizontally on surface of water.
Larva: with long breathing tube at end of body. Floats head downwards.	*Larva:* without prominent breathing tube. Floats horizontally.
Adult insect: with palpi much shorter than proboscis. Wings usually clear and colourless Rests with body parallel with support.	*Adult insect:* with palpi as long as proboscis. Wings usually spotted or clouded. Tilts the body at an angle to the support.

Thus by observing the position of rest taken up by the perfect insect on alighting upon one's hand one will be able to determine in most instances as to whether the insect is an *Anopheles* or not. The organism responsible for malarial fever is an animal organism named *Hœmamœba. It is small and unicellular, and* is found in the blood of a patient suffering from malarial fever. If left undisturbed the disease will be confined to this one man. If the latter is bitten by a certain kind of mosquito of the genus *Anopheles*, the mosquito takes in with the blood some of the *Hœmamœba.* These now undergo a true sexual cycle and the ♂ and ♀ parasites collect in the glands at the base of the proboscis of the mosquito. Should this latter then bite another person the parasites are injected into his blood and thus go through their asexual cycle in him and induce an attack of malarial fever in him. It thus becomes obvious that persons suffering from malarial fever should be carefully protected from the *Anopheles* mosquito by means of mosquito curtains, etc., or they themselves *become a centre from which others are infected.*

FAMILY SIMULIIDÆ (SAND FLIES).

Small fat flies with humped back, rather short legs and broad wings, with short straight antennæ destitute of setæ; proboscis not projecting.

There is only one genus, *Simulium*, of this family, but it is very widely spread and will probably prove to be nearly cosmopolitan. Some of the species are notorious for their blood sucking habits and in certain seasons, multiplying to an enormous extent, alight on cattle in thousands and induce a disease that produces death in a few hours. *Simulium columbaezense* has occasioned great losses *in this way* near the Danube. In India the family is represented by the well-known *potû* fly (*Simulium indicum*) of the North-west Himalayas. This insect is plentiful in the summer in the chir (*P. longifolia*) and deodar (*Cedrus deodara*) forests of these mountains: the species found in Assam may be

identical. It is most troublesome in the N.-W. Himalayan forests, as its bites are very irritating and produce blisters. The flight of the insect is noiseless and its bite at first so painless that the creature is seldom noticed until it has absorbed the blood from the wound. Brushing it away is then of no use. It leaves a characteristic mark due to the presence of a little globule of blood, about the size of a pin's head, beneath the skin. This rapidly turns black. The irritation produced varies in different pœple, but the insect has been known to drive whole camps of sawyers from the forest and to stop all work.

Series II.—Orthorrapha Brachycera.

Antennæ variable. Palpi only one= or two-jointed. The system of nervures in the wings is complex and there is no definite arched suture round the insertion of the antennæ.

Family Tabanidæ (Gad Flies).

The proboscis in this family is fleshy and projecting, the antennæ are said to be three-jointed, but the last joint is constricted, and therefore consists of apparently more than three joints. The head is short and broad, with very large eyes; mandibles (biting jaws) are only present in the female. The abdomen is flattened. The larvæ are cylindrical, some of them being aquatic, others living in the earth or in decaying wood; they are of predaceous habits, attacking and sucking insect larvæ or worms. The female flies suck the blood of Mammalia and are a great plague to horses, cattle and animals of all sorts in India.

Species of this family are very plentiful in India, and the large horse flies of the forest are well known to all foresters. It is these insects which drive large game, such as elephants, sambhur, etc., living at the foot of the Himalayas and other mountain ranges, to seek the higher hills, and consequently cooler climate, during the hot weather months in India, during which season the flies are particularly abundant.

Family Bombyliidæ.

Body is frequently fringed with down or covered in large part with hair. The legs are slender, claws being small, with only minute pulvilli. Proboscis very long and moderate, antennæ three-jointed, terminal joint not distinctly divided, sometimes large sometimes hairlike. This is a large family of flies and is of great importance to both naturalist and economist. There are two well marked types of fly in the Order (1) the *Bombyliides* with very long exserted rostrum and humped thorax; and (2) *Anthracides* with a short beak and of more slender thorax and graceful form. None of these flies are blood suckers; they frequent flowers only and use their long rostrum in a harmless manner. The wings are usually ornamented with a pattern, and the clothing of the

body is frequently variegated. It has recently been discovered that the larvæ of various species of *Bombyliidæ* are of great service in that they devour locust eggs, whilst a species of *Systropus* has been recorded as destroying the larvæ of *Limacodes*.

FAMILY ASILIDÆ (ROBBER FLIES).

This is one of the biggest families of flies, including over three thousand described species. In these flies the mouth forms a short projecting horny beak, the palpi being small. The body is elongated and hairy, and the feet have powerful claws, which are often thick and blunt. The insects are predaceous in the winged state and devour numbers of other insects. They prey upon large species and fear none, attacking wasps and other stinging insects and capturing even dragon flies and tiger beetles. Little is known about their larval stages in India.

SERIES III.—CYCLORRAPHA ASCHIZA.

Antennæ with not more than three joints, and these are furnished with an arista which is not terminal. Front of head has no definite arched suture over the antennæ.

FAMILY SYRPHIDÆ (HOVER FLIES).

Flies of moderate to rather large size, frequently spotted or banded with yellow, having very short, three-jointed antennæ and a cleft on the underside of the head in which the proboscis, which is thick and fleshy, can be withdrawn. This family is one of the largest and best known of the flies. Species abound in gardens and glades of the forest, where in sunny weather they may be seen hovering over flowers or in the rays of sunshine which pierce throrgh the leafy canopy of the trees. The larvæ are very diverse in appearance, and they live either upon plants or in water. Some feed upon *Aphidæ* or plant lice, and they may then be found on bushes or trees attacked by these blights devouring them with great voracity and in enormous numbers. The larvæ of *Syrphus nietneri* Schiner MS., and *Syrphus splendens* Dolesch, are said to prey in this way upon the coffee louse *Aphis coffeæ* in Ceylon.

SERIES IV.—CYCLORRAPHA SCHIZOPHORA.

Antenna has three joints and is furnished with an arista. The frontal suture over the antenna is often well marked. The nervures in wings are not so complex.

FAMILY TACHINIDÆ (PARASITIC FLIES).

This is an enormous family of flies, the larvæ of which live parasitically on other living insects, lepidopterous caterpillars being especially attacked. The antennal arista is bare, and thus thes einsects may be distinguished from the house fly, where it is plumose. The upper surface of the body is bristly. The insects of this family have in many cases a very great resemblance to the common

house fly. Many have been reared from the insects on which they live, but beyond this little is known of their life-histories. The eggs are usually desposited by the flies near or on the head of the victim. The grub on hatching out burrows into the caterpillar's body, but avoids the vital organs, so that the parasitised larva usually lives on until the dipterous grub is full fed, and it may even change into a pupa before death ensues. In the latter case the pupa will be found to contain one or more small fly pupæ according to the number of eggs laid upon or in and developed in the caterpillar. No moths will of course issue from pupæ attacked in this way. If the caterpillar dies before changing to the pupal state the fly maggots will cut their way out and change into pupæ on the outside alongside of the dead caterpillar skin, or they may burrow into the ground and pupate there. From the above it will be seen that these flies are of the very greatest importance and service to man, owing to their habit of destroying caterpillar, larvæ and thus keeping down swarms of defoliating larvæ. We are only just at the commencement of our researches in this respect in India, but there can be little doubt that these insects will well repay study. The writer has bred an as yet unnamed species out of the caterpillar of the destructive teak tree defoliator *Hyblœa puera* in the Nilumbur Plantations.

Members of the family are a serious nuisance to silkworm rearers, as unless special precautions are taken they destroy the worms wholesale. *Trycolyga bombycis* is parasitic upon the Eri and mulberry silkworms of Bengal and is very destructive. It is very like a large house fly in appearance. It in its turn is parasitised by a smaller fly named *Phora cleghorni*, which attacks it in much the same way it attacks the silk caterpillars.

A closely related family *Anthomyiidæ*, which has much the same characters as the *Tachinidæ*, contains the important fly *Anthomyia peshawarensis*, which is parasitic upon the eggs of the migratory locust *Acridium peregrinum*.

FAMILY MUSCIDÆ (HOUSE FLIES).

The arista is feathered, and by this they can be distinguished from the Tachnid flies, which they otherwise resemble. This family contains many of the most abundant species on the face of the earth, including the house fly, blue bottles or blow flies, and other forms. The larvæ live on carrion and decaying or excrementitious matter.

The common house fly, *Musca domestica*, runs through its life-history in a very short time. It lays about 150 very small eggs on dung or any soft damp filth; the larvæ hatch out in a day or two and feed on refuse; they may be full grown in five or six days, and then pupating, may emerge in another week as perfect flies. This accounts for their enormous and rapid increase when dirt and decaying matter is abundant. It has been calculated

that one female of the common house fly may have 25,000,000 descendants during one season.

The grubs of the fly *Rivellia persicæ* have been reported as seriously affecting the growth of the peach (*Prunus persica*) fruit in Chota Nagpur, whilst those of *Dacus ferrugineus* live in and considerably damage mangoes.

FAMILY OESTRIDÆ (BOT FLIES).

This is a small family of flies, the larvæ of which live in the bodies of vertebrates. The insects are large flies with very short antennæ, bearing a segmented arista; the front of the head is prominent, and the posterior part of the wings is often rough, and with very few veins. The family is of small extent, less than 100 species being known, yet it is of interest owing to the habits of its numbers. Some (*Gastrophilus*, etc.) live in their larval stage in the alimentary canal; others (*Hypoderma*, etc.) are encysted in or under the skin; while others (*Oestrus*, etc.), occupy the respiratory passages. Many of them attack the domestic animals used by man, and some even man himself. The life-histories are still very incompletely known. They do not bite the animals they attack, but deposit the eggs upon the hair of the skin or the young larvæ, already hatched, in the entrance of the nasal passages. The larvæ always quit the bodies of their hosts to pupate.

Horses, oxen, deer, sheep, etc., are attacked by these flies.

SERIES V.—PUPIPARA.

Often wingless flies or the wings are reduced in size. The young are produced alive, full-grown, but have still to undergo a metamorphosis. They are found in connection with vertebrates, and the habit of blood-sucking is probably common to both sexes.

FAMILY HIPPOBOSCIDÆ.

The wings are variable:—sometimes present and large when the surface is waved and the nervures are thick and confined to the anterior and basal part; at other times mere strips, whilst occasionally they are entirely absent. The proboscis differs from that of other flies, consisting of two hard flaps fitting close together, which can be opened, allowing an inner tube to be exserted from the head.

The family includes the horse fly and sheep tick.

NOTE.—The Sub-Order *Aphaniptera* includes the family *Pulicidæ* or fleas, which are wingless insects having the body laterally compressed, so that the transverse diameter is small and the vertical one great. It is unnecessary to do more than mention these insects here. They are known to all.

USEFUL DIPTERA.

The Order contains some insects whose habits render them of the gr. atest use to man. Amongst the *Cecidomyiidæ*, a family

containing some bad pests, there are some species which are predaceous, feeding actively upon *Aphidæ* or *Acari* and even upon their own relatives. The larvæ of the *Tabanidæ* are predaceous in habits, feeding upon other insect larvæ and worms. It has been discovered that some species of the *Bombyliidae* are of great service, in that they devour locust eggs, whilst one has been recorded as destroying the larva of *Limacodes*. As the adults of this family frequent flowers it is probable that they are of some service as pollen distributors.

The *Asilidæ* are predaceous in the winged state and devour numbers of other insects, attacking all species without fear. They probably do some harm in this way by attacking useful species, it being known that they will feed upon useful predaceous tiger beetles and dragon flies.

Some of the larva of the *Syrphidæ* are known to feed upon *Aphidæ*, whilst the family *Tachinidæ* include almost entirely parasitic species which feed within other insects, chiefly perhaps the caterpillars of *Lepidoptera*. The *Amthomyiidæ*, a closely-related family, contains the important fly *Amthomyia peshowarensis*, which is parasitic upon the eggs of the migratory locust of India, and thus renders great service to man by checking to some extent the increase of this pest.

THE ORDER THYSANOPTERA (THRIPS).

These are extremely abundant minute insects, which are to be found in profusion in flowers. They have four very narrow fringed wings and an imperfectly suctorial mouth. They are, as far as our present knowledge goes, of no importance to the forester, though species have been reported as injurious to turmeric, the opium poppy, and the leaves of the tea plant. It has been said that some feed upon *Aphidæ*, but the statement does not appear to be supported by sufficient evidence at present to render it of importance.

Effect of Leaf Covering on Soils.

AN excellent article in the *Revue des Eaux et Forêts* for December 1902, by Professor E. Henri, of the Forest School at Nancy in France, brings to notice the different experiments which have been conducted with the object of finding out what is the effect on the soil when the dead leaves, etc., are removed. In the forests of Europe, during autumn, the leaves fall from the trees and are heaped in stratified layers, together with dead branchlets, strips of bark and the remains of flowers and fruits, and these layers, before being converted into humus, are generally known as "the covering of dead vegetation."

This covering of dead vegetation is the only manure that the forest soils get, and the removal of it, which is some times

carried out for "litter," manure, etc., is extremely prejudicial to poor soils; and the more frequent the removal, and the longer it is practised, the worse are the results. In bad soils annual removal of this layer causes malformation of the tree growth, and in some cases death of the trees: and between 20 and 25 years, if the removal has been annual, it causes a decrease in growth amounting to 40 per cent., if biennial 25 per cent., if quadrennial 20 per cent., if sextennial 12 per cent. Natural *regeneration becomes quite impossible in poor soils,* and extremely difficult in better soils, owing to the hardening and drying up of the superficial layer, and to the malformation of the growth. The effect of the removal is simultaneously chemical and physical. Chemically it impoverishes the soils, already poor in themselves, by depriving them of appreciable quantities of lime, phosphoric acid, potash, nitrogen, etc., which would have been sufficient to maintain, and even improve, the forest vegetation. Physically it plays a prominent part in the formation and maintenance of the porosity of the soil; and as pointed out by numerous experiments—notably those of Wollny—the variations of temperature are least in a soil furnished with a covering of dead vegetation, and the action of such covering on the moisture of the soil is considerable. This action has often been quoted, but until recently there have been no experiments by which a definite conclusion could be arrived at. Some persons believed intuitively in such a covering causing a great increase in the moisture in the soil, but had no proof, and could give no statistics. Others, on the other hand, relied on the statistics of Dr. Ramann, and came to the conclusion that such covering made very little difference. But there is not the slightest doubt that Herr Fricke's recent experiments are based on very much sounder principles, and that they firmly establish the fact that this covering is most effective in increasing the moisture in *soils, and especially in soils* which have been cleared of forest vegetation. This is such a very important matter that it will be as well to give an outline of some of the experiments that have been made, and their results.

Wollny studied the question of the extent of the influence of this covering on the moisture of the soil, but only in localities *outside forests*; but in the forests the tops of the trees form an *obstacle to the wind and to the heat of the sun, and therefore* have great influence on the moisture in the soils. Wollny found (1) that soil with "a covering of dead vegetation". is far moister in summer than a bare soil of the same composition; (2) that the percentage of water in a soil with such covering increased with the thickness, but not proportionately to the thickness of the covering; (3) that the effect of the covering was to diminish the direct action of the causes of evaporation, that the wind and heat of the sun cannot exercise directly their drying influence through the covering, and are the less able to exercise it as the covering thickens; (4) that one inch thickness of leafy covering was enough

to reduce the evaporation sufficiently to keep the soil in a perpetual state of moisture; 5) that with layers thicker than this, up to four inches of thickness, the percentage of water does not increase, although the evaporation decreases, but keeps approximately the same, by filtration deeper into the soil; 6) that with layers exceeding 4 inches, the drainage water decreases, because large quantities of the water are absorbed by the covering itself. Wollny mooted the question as to whether the different effects of the covering on the moisture of the soil and drainage water were manifested in the same way in the forest, but as his experiments were made in areas of about two square yards, stocked with spruce of five years old, they could hardly be accepted as proper tests, but he found that, whereas the soils in previous tests gave 4 to 6 per cent of water, in the soil stocked with spruce without covering it amounted to 14·37 per cent. and with covering to 15·37 per cent.—an insignificant difference of 1 per cent.—and this slight difference he attributed to the more vigorous vegetation in the covered soil, as the trees find more humidity which they absorb, and more nutritive matter in the decomposing vegetable covering.

Dr. Ramann, Professor of the Forest Academy at Eberswalde, and Herr Schmidt, Inspector of Forests at Meiningen, made analyses of forest soils taken from the middle of the forests, and they both came to the conclusion that the covering made a difference of scarcely 1 per cent. of water; and it is due to these analyses that this opinion has become to a great extent the accepted one.

Herr Fricke, however, has recently pointed out that all experiments hitherto have been based upon the proportionate weight of the soil, and that this is by no means the proper method of computation by which to form a true idea of the percentage of water such as it exists in nature; that we do not want to know how much water there is in a given weight of soil, whose elements, consisting of pine needles, humus, vegetable mould, sand, pebbles, etc., have such different densities, but what quantity exists in a given space, taking into account their natural faculty of absorption; in other words, that the factor must not be computed by the weight but by the volume. This, of course, is a far more rational way of treating the subject than that of Dr. Ramann and Herr Schmidt, and the results of his experiment are very different.

On a sandy soil he took two sample areas, one with its vegetable covering, the other laid bare, in each of the following four types of forest: (1) old high forest 110 years old, trunks tall and straight, 60—70 feet high, but of medium girth; (2) pole forest, 50 years old, trunks 40 feet high, dense; (3) thicket, or sapling forest, 15 years old, fairly dense; and (4) a clean felled coupe. The experiments were conducted for 120 days, from April 19th to August 17th,

during which 94 days (*sic?* 104) were without rain and 16 days with rain, the weather being exceptionally hot and dry, and the results of evaporation were as follows: *High forest* with leaf covering 35 per cent., bare 41 per cent.; *pole forest* with covering 40 per cent., bare 47 per cent.; *thicket* with covering 39 per cent., bare 80 per cent.; *clear felling* with covering 67 per cent., bare 102 per cent. This shows that in the clear felling, when the leaf covering was removed, the evaporation was greater than the rainfall; but when the covering was not removed it was only two-thirds of the rainfall, that the effect of forest growth on evaporation is greater as the forest is older, but that, on the other hand, the removal of the vegetable covering has less effect as the forest is older.

He continued his experiments, and found that in winter the moisture in the plots deprived of this covering is nearly 20 per cent. less than that of those with covering. He conducted his experiments only to a depth of 16 inches for two reasons: firstly, because below that depth it becomes very difficult to determine the volume of the soil; and secondly, because he found that trees obtain their nourishment almost entirely within that limit. Thus he discovered that 70 to 80 per cent. of the root system of an old pine in poor alluvial soil was to be found within 12 inches of the surface. It is further pointed out that these differences are most accentuated in hot climates.

A. W. L.

VI.—EXTRACTS, NOTES AND QUERIES.

A Redwood Lumber Plant.

BY ENOS BROWN.

ONE of the results of the prosperity which the State of California is now enjoying is the revival of the lumber interests and the remarkable demand for export of the product of its redwood forests. Conditions are quite unprecedented. The redwood is found only in California, and in but a comparatively contracted area even there. From Santa Cruz county on the south to the Oregon line on the north it attains full development, but lower than Medocino county, owing to vicinity of the great market, the forests have been about exhausted and these localties are no longer considered producers. A considerable acreage in Santa Cruz county has been recently appropriated as public domain. The available redwood, therefore, is now confined to about 318 miles of coast. The annual product in this region is about 320,000,000 feet, and it is estimated at the present rate of consumption that enough standing timber exists to last for 150 years.

The redwood is rarely found beyond the reach of the ocean fogs, its extreme limit being thirty-five miles inshore, and then only when some valley-like depression prevents the entrance of fog to that distance. The tree seems to have an affinity for the salt sea fog, and attracts it about its lofty branches. There it condenses and falls to the ground in a gentle rain. The ground under the redwood tree is always moist.

The redwood is the *Sequoia sempervirens* of botanists, and is distinct from the *Sequoia gigantea* of the Sierras. The first is never found far from the sea, the latter always in the declivities of the Sierra Nevadas and seldom at an altitude lower than 4000 feet, and in a region where the rainfull is never excessive. In size they are much alike. The few remaining groves of the *Sequoia gigantea* are in Mariposa and Calaveras counties, California, and some of them are 400 feet in height and of tremendous girth. The timber is inferior to that of redwood, which is noted for endurance and strength. Its resistance to fire is no fable, but a sober fact. The lumber is becoming more in demand for decorative purposes. Its colour, a light salmon when first cut, afterwards turns to a deep red. When thoroughly dried there is no shrinkage, and it readily yields to the chisel of the carver. Piano cases made from the wood are said to give increased resonance to the instrument. Large quantities are consumed for interior finishing, with gratifying effects. In addition to other fine qualities the wood takes on beautiful polish, and even the stumpage, until recently considered worthless, is found to possess valuable qualities. The roots and woody excrescences at the base of the tree give fine effects in wavy outlines, and when polished the result is a material much valued for decorative purposes.

In the Eel River redwood district, Humboldt county, there are 80,000 acres of timber lands, which will produce at a low estimate 75,000 feet to the acre. In size the trees range from four to six feet in diameter; if below 18 inches they are left standing. Of the larger sizes from 8,000 to 12,000 feet is produced from each tree.

The tree illustrated was a growth of this valley and produced 80,000 feet of merchantable lumber.

Felling one of these enormous trees is an operation requiring great experience on the part of the woodsman. In the first place a tract is selected containing a goodly number of the proper sizes, as well as being advantageously located for getting the logs to the railroad for conveyance to the mill. The experience of the cutter will indicate the first and next in order to be felled. Each tree must lie in its own bed.

A platform is then erected surrounding the trunk from 6 to 8 feet above the ground. With a saw an undercut is made through the trunk, not quite to the centre, and from the opposite side a cross cut is sawed, ending a foot or two above the undercut and leaving a section of solid lumber between. The "gunsight," or the place where the tree is to fall, is then calculated to a certainty, and the ground cleared of all projections that would prevent the great trunk from falling flat on the earth. The woodsman who cannot calculate within a few feet the exact spot where the extreme top of a tree, no matter the height, will lie when down does not know his business. The rule is that when ten per cent. of a tree is "split" when felled, the chopper is incompetent and is discharged. When the exact place where the tree is to fall is selected, the choppers ascend the platform, and with axes hew out an angular shaped piece having the undercut as a base. When this cut is made the second, or crosscut, is wedged until the tree topples over and falls to the ground, the solid section of the trunk not pierced by the cuts, supporting the tree until the centre of gravity is passed, and then the mighty frame falls upon its prepared bed almost intact.

The next operation is performed by the "ringers" and "peelers." Every 12 or 14 feet, as required, a ring is cut around the circumference of the bark, and afterward the peelers with crowbars and wedges "peel" the bark from the prostrate trunk. Finally all of the trees are stripped, but surrounded with an immense accumulation of debris of bark and branches, which must be removed before the trunks can be sawed into suitable lengths for conveyance to the mill. The ground is cleared by fire, precaution being first taken to plug up the "splits" in the trunk with clay so that the fire may not reach the interior of the tree. A foggy day is chosen and a still one. Fire is started and in a short time the track is burning with a fierce heat that quickly reduces the piles of bark and brush to ashes, and leaves an

unobstructed field for the removal of the timber, which has been scarcely charred by the intense heat to which it has been subjected.

The trunks as they lie are then cut into stated lengths with crosscut saws and then follows the arduous task of conveying these enormously heavy sections to the railroad. This operation is one of extreme difficulty, involving the transportation of the logs from the high and precipitous hillsides, and conveying them uninjured over long distances.

Temporary skidways are laid down and roads constructed. Chutes down which the logs pass have to be planned, and on these, guided by the skilful woodsmen, the unwieldy logs at last reach their destination. The work is laborious in the extreme, and is assisted by donkey engines on sleds, which are hauled to the top of the steep banks and into seemingly impossible situations. With the aid of these engines loading on cars is accomplished without special difficulty. Twenty-five miles of broad gauge track penetrate into all parts of this district, and 180 flat cars are employed in transporting the timber and finished products.

Scotia, the town where the immense manufacturing plant of the Pacific Lumber Company is located, is situated twenty-five miles from the mouth of Eel River. Schools, churches and dwellings are owned by the Company, as well as the land upon which they are built. It is a community prosperous and contented. The pond at the millside has room for 4,000,000 feet of logs, which are drawn upon when the rains of winter season render logging impracticable. The capacity of the mill is 175,000 feet per day, exclusive of 500,000 shingles and large number of railroad ties.—*Scientific American.*

Transvaal Forestry.

Mr. D. E. Hutchins, the Cape Conservator of Forests, who read a paper before the Society in 1899 on "National Forestry," has lately addressed the Transvaal Section of the South African Association at Johannesburg, on "Transvaal Forestry."

He stated that before the war there was a yearly average of close on half a million pounds' worth of timber imported through Cape and Natal ports, and £140,000 worth through Delagoa Bay; the larger part of this going through to the Transvaal. Half a million pounds' worth of timber came through Cape ports during 1901. Of this the greater portion was soft wood used in house building, and most of the balance hardwood for sleepers. Return of timber imported into the Transvaal,

1897 and 1898 - 1897: Manufactured, £258,741; unmanufactured, £178,145; total, £436,886. 1898: Manufactured, £217,447; unmanufactured, £130,013; total, £347,460. During the last 21 years the Cape Administration had spent over a quarter of a million on forestry. Timber was a necessity in a civilised country. Civilised man could no more do without timber than without air and water. It was not at all unlikely that the Transvaal during the next few years would require half a million pounds' worth yearly of unmanufactured timber or lumber. Was this to be brought 6000 or 7000 miles by sea from Australia or Europe? Obviously, the Transvaal could grow much of its own supply at a good profit. The Transvaal forestry possibilities can no more be allowed to lie idle than its mines. The Transvaal has a forest-producing power which is many times that of Europe, and every month that is lost in putting this forest-producing power into action is a dead loss to the country. What is required at once is the demarcation of the forest reserves, that is to say, the areas which will form the future national forests of the country, and the setting aside of funds, say £100,000 yearly, to afforest those reserves. After giving further details, the lecturer concluded as follows:—"Forestry should be regarded not as a branch of agriculture to be assisted by a benevolent Government, but as a great public work of pressing necessity. We have seen how, on the most moderate computation, most kinds of timber can be grown at a profit of 400 per cent., and the present high price of timber reduced by two-thirds. The good soils and fertility of the Transvaal are proverbial in South Africa. Foresters' measurements show how powerful is the vegetative process in the Transvaal, and how vast the wealth of its potential forests. The coal deposits are evidence of the rich vegetation of the past. And let us not forget the ennobling effect of forests, their fostering the love of the beautiful in Nature. Your coal is grimy, your gold is in the gloomy mines, but your forests should be the pastime and glory of your people, the health and wealth of your children."—*Journal of the Society of Arts.*

The American Bureau of Forestry.

The American Bureau of Forestry came into existence a little over a year ago, and its first year's work is treated of in a Report published by its Chief. In this paper * we propose to glance at the year's work and to show what the objects of the Bureau are. We may premise by saying that the Bureau is under the Agricultural Minister, and that it has charge of the scientific and technical work of the Government. It consists of a Chief called the Forester, under whom are a number of specialists who study the numerous important technical questions which, if a good and successful forest management is to be ensured, require to be worked out.

Amongst the scientific problems which call for the services of specialists may be mentioned the following :—The careful study of the various forests with a view to the preparation of working plans, the study of commercial trees and minor products, fires and grazing, chemical questions, planting, forest entomology, etc. One and all of these subjects are in America studied on the spot by men who devote their whole time and energies to the particular branches they have made their own. To facilitate the research work the Bureau has certain small but important Reserves under its management where experimental work is being constantly carried on.

It can scarcely be doubted, I think, that this is the way to ensure the best results being obtained—both monetary and otherwise—from the forests of a country. Enquiries so carried out and recommendations made, based on the broad views formed by men with a knowledge of the requirements of the country as a whole and not upon an acquainance with small local areas only, are likely to prove much more satisfactory than the unavoidably narrower ideas of the local officer in charge who naturally works for his own forest with but little idea as to what may be being done in the same direction, with a better chance of success, elsewhere.

The work of a coterie of specialists has been found to be a great success from a commercial point of view, as the cost of up-keep of such an establishment is soon repaid by the greater revenue which their researches and recommendations enable the local officers to obtain from the forests under their charge.

During its first year as a Bureau, what was known in America formerly as the Division of Forestry has rapidly assumed the character and functions of its new position. With the increased capacity to do its work, the Bureau has gained in stability and effectiveness, and in the character and value of its results. While, owing to the lack of American foresters, it yet falls below a

*This article is based on an excellent summary of the Forester's (the Chief of the Bureau) Report in our contemporary 'Forestry and Irrigation.' —HON. ED.

high standard of equipment in trained men, a larger proportion of educated foresters than ever before was engaged in its work, both in the office and in the field during the year. The organization of work made possible by the change from a Division to a Bureau has been of capital value throughout the year.

The progress of public interest in forestry during the year far more than kept pace with the growth of the Bureau. The demands for advice and assistance increase from month to month, and continue to outstrip more and more the ability of the Bureau to meet them. The time for the general introduction of practical forestry in the United States has evidently arrived, and the difficulty experienced is to meet all the calls now made upon it. The inability of the Bureau of Forestry to meet this demand because of inadequate resources is thus the most serious bar to the protection and perpetuation of our forests. With, however, the rapid extension of professional education in forestry, the need of the Bureau for trained foresters can, it is hoped, next year be met more nearly than ever before. In view of the increasingly rapid destruction of the forests, it is most fortunate that the imperative demand for assistance in checking the loss is paralleled by the opportunity to supply the demand. A money grant is required for the work.

Division of Forest Management.

Private lands.—Of course private forests are numerous and of great value in the United States, and the demands for assistance in introducing practical forestry on these private lands increased during the past year almost as much as during the three preceding years. These applications have now reached a total of 4,709,120 acres, under an arrangement by which the owners pay all expenses of the field work except the salaries of members of the Bureau.

The total area of private forests under conservative management, however, reached only the comparatively insignificant total of 372,463 acres, or 7·9 per cent of the total applications. The Bureau has thus been obliged, owing to lack of men and money, to neglect or defer over 90 per cent of its opportunities to introduce practical forestry on private lands.

As the greater bulk of the forests in the United States are in private ownership, it follows that forest protection by the Government, while absolutely of vast importance, is relatively insignificant when compared with the action of the lumbermen and other private owners. In the light of these facts, the inability of the Bureau to respond to more than 8 per cent of the requests for advice in applying the principles which it continually advocates is seen to be the most dangerous of all checks on the progress of forestry.

Field work on seven large forest tracts was completed during the year, and preliminary examinations were made of 1,620,000 acres. The amount paid by the owners for the preparation by the Bureau of working plans for their forests was $13,325.

Public lands.—The preparation of working plans for conservative working in the public forest reserves has, at the request of the Secretary of the Interior, continued throughout the year. The total area of these reserves on September 1, 1902, was 58,850,925 acres. Field work was carried on during the past year in five reserves. In addition to field work and the computation of results in the office, the force of the Bureau was drawn upon to supply the entire number of trained foresters required for the management of the national forest reserves.

During the year a request was made by the Secretary of War for working plans for eight military wood and timber reservations, with a total area of 117,468 acres. Among these is the military reservation at West Point, upon which field work will be begun without delay.

Field work was completed on townships 5, 6, and 41 of the Adirondack Forest Reserve, by the use of an appropriation of $3,500 made by the New York Legislature to cover the field expenses of the Bureau of Forestry.

Forest measurements.—The force employed in computing field results was thoroughly organized. It completed during the year computations of 16,678 acres, and measurements of the rate of growth of 10,786 trees, of 25 species, in 13 States.

Division of Forest Investigation.

Commercial trees.—Measurements and sylvicultural facts were gathered for 20 species in various parts of the country. Studies of hardwood sprout lands were carried on in Massachusetts and other parts of New England, and promise valuable results. A special investigation of the Big Trees of California was begun, and is still in progress, and a preliminary study of the swamp forests of eastern Missouri and Arkansas was undertaken.

Studies of North American Forests.—The forests of Nebraska were made the subject of an elaborate report, and at the request of the Michigan Forest Commission an investigation of lands in the southern peninsula of Michigan was made, with special reference to the proper management of the Michigan Forest Reserve. Special studies of forest conditions were pushed forward in Kentucky, Ohio, and Texas, and of the distribution of forests in certain portions of New Mexico, Arizona, South Dakota, Wyoming, Montana, and California. In California the study of the relation of forest cover to the flow of streams was continued, and the results will shortly be ready for publication. In co-operation with the U. S. Geological Survey,

the study of the Sierra Forest Reserve was completed. In Vermont a co-operative study of the forest resources and conditions of the State was completed, and in Maryland the mapping of the forests by counties, begun in 1899, was continued. Attention was given, both in the office and in the field, to the region of the proposed Appalachian Forest Reserve.

Fires and grazing.—Investigations of the effect of grazing on the forest were conducted in Washington, Oregon, Wyoming, New Mexico, Utah, and California. The study of forest fires was conducted in twelve States, and the preparation of a report upon this subject is in hand.

Chemical investigations.—Special attention has been given during the year by the Bureau specialist to the chemical investigation of tan extracts from native woods and barks, and of gums from the Philippine Islands. The study of pulp woods, with special reference to the qualifications of untried species, has been carried forward. The great commercial value of these investigations needs no dilating upon here.

Turpentine orcharding.—The investigation conducted by the Bureau into the methods of producing naval stores in the South-Eastern United States has resulted in the development of a method which it is believed will radically affect the whole industry. A report is in preparation describing its actual operation.

Forest entomology.—A commencement has been made in the investigation of insect damage to the forests with the direct purpose of devising remedies. The vast importance of the subject makes the continuance of this work imperative, and the work is being pursued with energy by a specialist.

Various studies.—Investigations of the lumber industry of the State of New York and the Maple sugar industry of the United States were completed, and a study of the osier willow industry was begun.

A careful investigation of the Eucalypts and Acacias cultivated in the United States was completed, and bulletins were prepared for each.

Timber conservation and supplies.—In co-operation with the Bureau of Plant Industry, great progress was made during the year in arousing the interest of mining and railroad companies in the preservation of timbers and in the sources of timber supply. The practical assistance of many railroads toward the establishment of conservative forestry was begun, and the work shows conspicuous promise.

Forest exhibit.—A forest exhibit was prepared and installed at the Pan-American Exposition, at Buffalo, and later transferred to Charleston, S. C.

TREE PLANTING.

Planting plans.—The co-operation of the Bureau of Forestry with the owners of timber land is paralleled by its co-operation with the owners of treeless areas who wish to plant. Up to June 30, 1902, there were received 262 applications for assistance, in response to 224 of which planting plans were prepared. In the course of the work 197,439 acres of land were examined. The area to be planted under plans already prepared is 6,474 acres. These plans cover 29 States and territories and 172 different localities.

Planted woodlands.—In order to use the information already at hand from previous planting, careful studies of 20 large plantations, 8 in the Middle West and 12 in the East, were carried on during the year. A similar study is now under way to find trees adapted for the south-western plains.

Forest extension.—Studies of the natural extension of forests were continued during the year. A careful forest survey of a large part of Nebraska was completed, and resulted not only in arousing great interest throughout that State, but in the creation of two forest reserves for tree planting, a most valuable contribution to the forest policy of the United States.

Reserve planting.—Preparations for planting considerable areas in the two reserves in Nebraska were made during the latter part of the fiscal year.

Sand dunes.—Investigations with a view to preventing damage from drifting sand dunes were begun during the year, both on the Atlantic and Pacific coasts, and promise results of great value, especially along the Columbia River.

OFFICE WORK.

The office work of the Bureau has continued to increase steadily in efficiency throughout the year.

The collection of forest literature from the Department library was transferred to the library of the Bureau, which now contains 1,120 bound volumes, 1,900 pamphlets, and numerous periodical publications.

Eight new publications and ten reprints were printed during the year with a total number of 77,200 and 127,500 copies respectively.

The photographic collection was largely increased, and is now serving as the source from which nearly all forest illustrations are derived. In this connection a photographic laboratory has been prepared at the quarters of the Bureau, and was nearly ready for occupancy at the end of the fiscal year.

Although American forestry is in its infancy, the above summary of the Bureau's report for the first year of its existence shows

that the Forest authorities have thoroughly realized the position of affairs, and, headed by their President, himself an enthusiastic advocate of a broad and liberal forest policy and the prompt formation of large reserves as his recent speeches in Congress bear ample witness to, they are undoubtedly on the straight road which leads to success.

That they should thus have grasped so accurately the true lines upon which a broad and enlightened forest policy should be based is doubtless in part due to the great power the nation possesses of going unerringly to the root of a question and seizing *and applying only the best of the methods practised by other* countries to their own ends. Nevertheless we feel that to the fortunate possession of, and moral support given by, such a President as Roosevelt at this juncture the American Forest Department doubtless owe much of their present enlightened methods of dealing with the subject. An ardent sportsman and a deep and true lover of nature, President Roosevelt has roamed about the vast forests himself, and seen for himself the great necessity of their preservation and restoration to something of their prestine greatness. It was at once grasped that to carry out such a work *satisfactorily*, and to ensure a continuity in the careful study of each of its individual scientific and commercial aspects the services of specialists in each of these were necessary, and the securing of such and their collection together into one Bureau, after the manner of the great European Forest States, followed in the natural sequence of events.

We trust to give in our next issue 'Notes from an American Forest Reserve,' in which the local Forest Officer gives his opinion *on the satisfactory position of affairs,* and tells us about his side of the work.

Damage to teak by drought in the Panch Mahals of the Bombay Presidency.

A good deal has already been written with regard to damage done to forests by drought during the famine year of 1899-1900. I however venture to add some further remarks regarding the damage done to teak in this division, hoping it may interest some foresters who have to deal with forests under similar circumstances.

The Panch Mahals are situated on the extreme northern limit of teak growth in western India, and consequently trees of large dimensions are not found. The soil varies from sandy loam to black soil. The country is generally speaking flat, except in the extreme north where small hills occur, caused by outcrops of granite, gneiss and small quantities of slaty schists. The depth of the soil varies from 1 to 5 feet, after which rock or hard murrum is found. The rainfall is about 40 inches and the altitude 350 ft.

The forests consist of nearly pure teak and teak mixed with various other species, which need not be specified, as I only propose

to speak of teak. It will be sufficient to state that nearly every forest contains at least 40 per cent of teak.

Of the standing teak in these forests an average of 45 per cent of the trees have been either killed outright or so much damaged that they will never improve. In some forests the drought has killed 90 per cent of the trees and over, while others have suffered less, but there is hardly an acre untouched.

When walking through these jungles the first point which strikes one is that trees of approximately the same age and size, *standing within a few yards of each other, often give absolutely* different results; one being completely dry and the other quite flourishing and untouched by drought. In other places you find patches of living trees covering an area of, say, 100 yards square and surrounded by dead trees, the surface soil being to all appearances similar and on the same level.

Where trees were found green, I put it down to a local depression of the subsoil. It however being unlikely that the level of the subsoil would vary from yard to yard, this would not hold good for trees standing side by side. The only way left to determine the cause was to dig up a number of trees in different forests, standing on different soils. This was done, taking whenever possible an entirely dead tree standing close to a living one, so as to compare the depth of soil and their respective root systems. As an example a few of the measurements of the sample trees are given below:—

No.	Soil.	Age.	Diam.	Height.	Depth of soil to rock or murrum.	REMARKS.
		Ft.	In.	Ft.	Ft.	
1	Black ...	26	6	26	3	Stem dry, roots green.
2	Do. ...	27	9	37	3	Quite green.
3	Do. ...	35	9	27	2½	Stem half green, crown dry.
4	Do. ...	28	10	34	2½	Entirely dry, both stem and root.
*5	Do. ...	25	7	30	2½	Ditto.
*6	Do. ...	30	9	40	3	Quite green.
7	Sandy loam.	18	7	40	3	Ditto.
8	Ditto. ...	28	6	35	2	Quite dry, both stem and root.
9	Ditto. ...	29	7	45	2½	Ditto.
*	*	*	*	*	*	*

The ground below the depth given above was found to be either rock or hard murrum. It will be seen the soil does not vary in depth more then 6 inches except in No. 9.

* Illustrations of the root systems of these two are given.

Now a variation of 6 inches could hardly account for a tree being completely dry or green, so the cause had to be looked for elsewhere. One had not far to search, for, firstly, those trees which were found green had central or tap roots going down to the hard layer, and, secondly, their large spreading roots were generally speaking found to be sloping downwards in the subsoil and to be more vigorous. On the other hand, the dry trees were found to have practically no tap roots and their spreading roots were lying

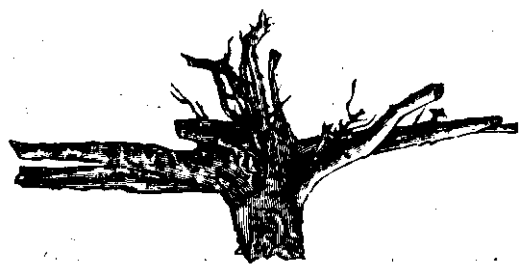

Fig. 1 *Roots of a Green Tree.*

only a few inches below the surface. The two illustrations,* one of the roots of a green tree (Fig. 1), and the other of a completely dry tree (Fig. 2), are fairly typical examples, and will better explain the condition of the root systems, though the roots of the green tree shown do not slope downwards as much as some of the other sample trees dug up.

Fig. 2 *Roots of a Dry Tree.*

So severe has been the damage that it has been deemed necessary to suspend the proper working plans † and introduce temporary plans for cutting out the dead and half dead teak and other species. Luckily there is an excellent demand for fuel and rafters, so that the work can be carried on rapidly, and will probably be completed by the end of 1905. Had the demand

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* The illustrations are from drawings made from photographs sent by the Author.—HON. ED.

† We believe we are correct in stating that this had to be done in the Seoni Teak Forests of the Central Provinces in 1901 for similar reasons. It would be interesting to hear whether any examination of the root systems was made in that locality. Perhaps the Divisional Officer would kindly let us know in these columns.—HON. ED.

been poor, most of this wood would have been destroyed by fires, which are extremely hard to keep out of these very inflammable jungles.

For the purpose of finding out the cause of death, the sample trees taken were of the two extremes, *i. e.*, quite green or entirely dry. The reader might therefore be wrongly lead to believe that all damaged trees were lost to the forest; the entirely dry ones are gone, but there is a redeeming point in the situation, and that is that of the greater percentage of the damaged trees though the stems are dry the roots generally speaking are green or partly so, so that, the forests being worked on a coppice system, the regeneration is secured, always provided the young shoots are not killed by fire.

R. S. P.

The Insect World in an Indian Forest and how to Study it.

BY E. P. STEBBING, F. L. S., F. E. S.

(*Continued from p.* 238).

PART VIII.

THE ORDER *HEMIPTERA* OR *RHYNCHOTA*.

The *Hemiptera* or Bugs are perhaps better known as Rhynchota. They are insects whose mouth parts consist of a proboscis or beak (usually concealed by being bent under the body) which has the appearence of a transversely-jointed rod or sheath in which are enclosed long slender processes like horse-hair, which are used for piercing plant substances. The possession of this form of mouth parts renders it easy to distinguish the insects of this order. The Lice which belong here have not this jointed beak; these will be referred to later on. *Hemiptera* are without exception *sucking insects, and the mouth parts of the individual* are of one form throughout life, there being no pupal stage in the order. The thorax is always very distinct and often large, both the meso and meta-thorax being well developed and the scutellum of the former is frequently very large, at times covering the entire dorsal surface of the body. The wings are usually four in number. The upper half of the upper wing is in some cases horny, the wings then shutting flat on the back; or they may be membranous and fold on the back in a roof-shaped manner. The young resembles the adult in general form; the wings are developed outside the body by growth at the different moults.

There is often an ovipositor in the female. About 18,000 species have been described, and there is probably no order of insects which is so directly connected with the welfare of the human race as the *Hemiptera*; it is probable that if anything were *to exterminte the enemies of the Rhynchota man himself would be* starved off the face of the earth in a few months. Their operations

escape observation to a large extent, as they merely make pricks in the food plant and then suck away its sap without in many cases leaving any very evident marks of their former presence. Thus nothing being observable, injuries really due to *Hemiptera* often attributed to other causes.

For our purpose we will divide the order into two sub-orders. *Heteroptera* or true Bugs and the *Homoptera*, which include the scale insects, cicadas, blights, &c.

SUB-ORDER HETEROPTERA.

Front of head does not touch the coxæ (hips). The anterior wings are more horny than the posterior pair and fold flat on the back, their apical portions usually more membranous than the bases, which are horny. The lower portion of the right wing overlaps the left at tip.

FAMILY PENTATOMIDAE.

This is the largest family of the *Heteroptera*, including some 4,000 species. The insects can be recognised by the large scutellum which is at least half as long as the abdomen and often covers the whole of the after part of the body and wings. Antennæ are often five-jointed and the proboscis sheath is four-jointed. Their ocelli are two in number, and thence there is an appendage to each tarsal claw. The colouration in these insects is often very vivid. This family contains a number of pests and one or two useful predacious insects.

An insect named *Ochrophara montana* has proved a serious pest to bamboo seed. The following is known about its life history:—It feeds in both larval and adult stages upon the developing seed of the bamboo, *Dendrocalamus strictus*. In 1900 it appeared in the Central Provinces in enormous numbers in the middle of January, and fed voraciously upon the ripening seed until the middle of March, and then disappeared, having probably laid its eggs somewhere first. Nothing further appears to have been recorded on the life-history of this pest.*

Canthecona furcellata Wolff is a small active yellowish bug which is said to destroy tusser silk worms. It probably also feeds upon noxious defoliating caterpillars.

FAMILY COREIDÆ.

The members of this family are readily recognised by the following characters:—The scutellum is smaller than in the last and does not reach to the middle of the body; the proboscis sheath is four-jointed and ocelli are present; antennæ are generally elongate and four-jointed, and are inserted on the upper parts of the sides of the head. The femora of the legs are not knobbed at the tip.

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* *Vide* Departmental Notes on Insects that affect Forestry, No. 1, p. 123. Id, p. 126.

These insects are rarely of brilliant colours.

The family includes a very destructive species in India known in the Rice-sapper. An insect known as *Ceratopachys variabilis* feeds upon the jhand (*Prosopis spicigera*) in the Punjab and has the following life-history:—The bugs commence feeding in February, having hibernated through the cold weather months as half grown larvæ, becoming full grown in March. They then pair and eggs are laid. The next generation takes about ten weeks to pass through—two weeks being spent as a wingless larva, two with rudimentary wings and three whilst their rudimentary wings are becoming fully developed. The number of summer generations has not yet been ascertained. The insect finally hibernates at the beginning of November The eggs when first laid are of a brilliant green colour, which soon turns to reddish brown. The insect itself is green and red in colour. It appears to confine its attacks to one-year old coppice shoots.

FAMILY LYGAEIDÆ.

The characters of the members of this family are the same as those of the *Coreidæ*, the insects only differing in the insertion of the antennæ; the upper surface or face of the insect is not flat but is transversely convex, so that when seen in profile the antennæ appear to be inserted well down upon the sides of the head. The family contains some injurious insects. Most of the known Indian species are reddish in colour such, *e.g.*, as the red cotton bug and other plant-feeding forms.

FAMILY REDUVIIDÆ.

These insects are easily recognisable by their freely moveable elongate head and by the short curved proboscis which does not extend on to the breast. They can at times inflict a wound with their proboscis. The eyes are placed much in front of the thorax and the ocelli when present are behind the compound eyes. The insects are only of importance owing to their predaceous habits. They feed upon other insects and probably destroy large numbers of injurious forms. Some members of the family live under bark and feed upon wood and bark-boring beetles. A species has been found engaged in this manner under spruce bark in N.-W. Himalayas.

FAMILY CAPSIDÆ.

These are moderate-sized or small bugs of delicate consistence. They have no ocelli present. The elytra and wings are usually large in proportion to the body. Antennæ are four-jointed, the second joint being usually very long and the terminal two more slender than the others. There is no groove on the under-surface for the proboscis to fit into. The scutellum is exposed and moderately large. Tarsi three-jointed. The female has an ovipositor which she can put out and draw in at will. The family is a large one, the insects being delicately coloured and never metallic. They frequent plants of all kinds and many of them skip by the

aid of their wings with great agility in the sunshine. The majority suck the juices of plants, but some are known to prey upon other insects.

The best known Indian genus is *Helopeltis* to which the "mosquito blight" of tea belongs. These insects possess a knobbed spine projecting straight up from the scutellum. The egg is placed by the bug in the stems of the tea plant, but attached to one end of the egg are two long slender threads which project externally. The insects on hatching out suck up the juices of the plant.

Disphinctus humeralis Wlk. is a small insect which has been reported as attacking cinchona in Sikkim. Little seems to be at present known about it.

Note—The various bugs which live in water, known as *Cryptocerata*, belong to this sub-order. They are provided with swimming legs.

SUB-ORDER HOMOPTERA.

The front of the head is much inflexed so as to be in contact with the coxæ. The anterior wings are of the same consistency throughout and do not overlap at the tips. This sub-order is divided into three series according to the number of tarsal joints present on the feet of the insects—the *Trimera* having three, *Dimera* two and *Monomera* one tarsal joint respectively.

SERIES TRIMERA.

Tarsi usually three jointed.

FAMILY CICADIDÆ (CICADAS).

These insects are as far as is at present known seen above ground only in the perfect condition, spending the earlier larval stages in the ground upon roots. They can be recognised by having a head with three ocelli placed triangularly upon the summit between the compound eyes; the antennæ consist of a short basal joint surmounted by a hair-like process divided into about five segments. The front femora are more or less thickened and are armed with teeth.

The family consists of large insects with the four wings transparent and shining, the nervures being distinct and dark-coloured. The insects are sometimes brightly coloured, black and yellow being the predominant tints. The body is broad and robust. They are mostly tropical insects.

The cicadas produce the curious whirring sound which is so characteristic of the lower hill forests of India. The sound is produced by the male by means of a specially modified stigmata which can be seen at the base of the hind legs. The eggs are laid by the female in the branches of trees in which she makes incisions with her ovipositor. On hatching out the young larvæ crawl down to the ground and bury themselves in the earth, where

they feed upon the roots and may spend several years in this stage of their existence. They usually, if not always, leave the ground before the last moult or shedding of the last skin, this being often done upon the trunks of trees, etc. After shedding this last skin the insects are fully developed; they then pair and lay eggs. The life-histories are little understood, but cisadas appear at intervals in swarms rather after the manner of the appearance of the N.-W. locust over India.

Family Fulgoridæ.

These insects can be best distinguished by the fact that the two ocelli present are placed beneath the eyes or near the eyes, usually in cavities of the cheeks. The antennæ are placed beneath the eyes and are very variable in form, usually consisting of two joints terminated by a very fine hair. The prothorax is not armed with spines, etc., and is of normal size. Some of the insects are very large, others quite small. The family includes the so-called Lantern flies, in which the front of the head forms a huge misshapen proboscis, which was formerly believed to be luminous. Many of the species are of bright colouration. A number have the power of excreting large quantities of a white flocculent wax. The wax of a Chinese fulgorid was used to make wax candles, in which there was a large trade before kerosine oil came into general use. The insect known as White Insect Wax, *Ceroplastes ceriferus*, is an inhabitant of Central and Southern India. It secretes little conical masses of a sweet white waxy substance around it, and is to be found at times fairly numerous upon pipal trees. These white masses are sought for eagerly by jungle tribes, especially children, and eaten with relish. This wax was tried for candle purposes before the days of kerosine, as it was hoped that it would be able to rival the Chinese form, but it was found to burn with a smoky flame.

A large typical fulgorid was plentiful on the teak in the South Coimbatore forests in July 1902. Its history, which is likely to prove interesting, requires working out.

Family Membracidæ.

This family is of large extent, its members being chiefly tropical, and are specially abundant in America, and probably so in India, but little is known about them in this latter country. The insects are of curious form; the prothorax is prolonged backwards into a hood or processes of various shapes; the antennæ are inserted in front of the eyes, and there are two ocelli placed between the eyes. The young have but little resemblance to the adults, the great thoracic hood being absent, while on the back there is on each segment a pair of long half-erect processes having fringed margins.

FAMILY CERCOPIDÆ.

There are two ocelli (occasionally absent) which are placed upon the vertex; the antennæ are placed between the eyes. The thorax is not peculiarly formed.

These insects are the common cuckoo-spits, so-called from the habit of the larvæ of emitting a liquid which it secretes in large amounts in the form of bubbles which accumulate round the insect and conceal it. The adults are known as frog-hoppers, their power of leaping being very great. Cercopidæ are common on the leaves of many trees in Indian forests, though at present very little is known about them.

The eggs are laid upon the food plant, and the insect lives upon it in all its stages.

A large cuckoo spit in its typical froth bubble was plentiful on the teak in the South Coimbatore forests in July 1902.

FAMILY JASSIDÆ (CICADELLINÆ).

A large number of small or minute insects are included here. The insects are usually of narrow parallel form and frequently excessively delicate and fragile. Ocelli are two in number, placed just on the front margin of the head (almost in a line with the front of the eyes, or more in the front, or on the deflexed forehead.) Hind tibiæ usually with many spines. The mango jassids of which three species, *Idiocerus nivcosparsus*, *I. clypealis* and *I. atkinsonii* are known, suck the juices of the young shoots, young leaves and flowers of the mango, at times to such an extent that light crops of fruit are the result.

SERIES DIMERA.

Tarsi usually two-jointed.

FAMILY PSYLLIDÆ.

Minute insects with usually transparent wings placed in a roof-shaped manner over the body; three ocelli are present and the antennæ are long and thin consisting of eight to ten joints. Very little is known about the Indian forms of this family. They are sometimes called springing plant lice as their habit of jumping distinguishes them from the *Aphidæ*. They vary remarkably in colour, the latter apparently depending upon the age of the individual, the food plant, the climate and more particularly the season of the year. The insects probably pass through several generations in the year. The young larvæ differ in form from the adult. Psyllidæ excrete or exude from their bodies matter which is sometimes called honeydew; these exudations are often in large quantities, the substance raining down from the trees on to the vegetation beneath An insect named *Psylla cistellata* attacks and aborts mango shoots, whilst another, *Phacopteron lentiginosum*, forms galls upon the *Garuga pinnata* and a third galls upon *Diospyros melanoxylon*.

FAMILY.—APHIDÆ (BLIGHTS).

A large family of minute insects which are extremely injurious to vegetation, and are likely to be found very destructive in Indian forests when more is known about them. As usually met with they are destitute of wings, though many species have two pairs of transparent wings, which have a very characteristic neuration. In the wing there is one main nervure which forks, and from the fork another forked vein is given off. This is characteristic of the Aphid wing. The antennæ are long or moderately *so, and are from three to seven-jointed*; the abdomen has often a pair of tubes or short processes upon the upper side of the fifth abdominal segment which secrete saccharine solutions. The first joint of the two-jointed tarsus is sometimes very short.

These thin-skinned insects are sometimes called 'blight,' and during the warm months of the year they are capable of increasing in enormous numbers. This is due to peculiarities in their life-histories, which render this family a very important one in the economy of nature. The body is soft, often bulky, pear-shaped, and green, yellow, brown or black in colour. The surface is often covered with waxy blooms. Legs are feeble and the wings *are often absent in the females. An Aphis is injurious owing to* the enormous amount of sap it extracts from the plant on which it feeds, and also owing to the fact that it clogs up the stomata of a plant with the saccharine solutions which it exudes. A fungus often arises from this sticky solution, *e.g.*, in the case of the Bamboo Aphis, which is common in India, a black fungus grows in the sweet matter it exudes and forms a felt-like mass on the stems.

The eggs are laid on the plant in the autumn, and remain there till the spring, when there hatch out from them wingless females, which do not lay eggs but produce young parthenogeni*tically. This goes on till autumn*, the young reaching maturity in a week or ten days under favourable circumstances, and bearing young parthenogenitically in their turn, the insect thus multiplying exceedingly rapidly and in very large numbers. In autumn the last brood produced are males and females, the latter being usually wingless. These pair and eggs are laid. The winter is passed through in this stage, and the wingless stem mother hatches out in the succeeding spring. The life-history is sometimes varied by some of the females of the last generation having wings. These may then fly off to another plant, and lay their eggs on it. This occurs in the case of the genus Chermes, whose life-history we will shortly consider:—In this genus the winter is passed through by the stem mother, who takes shelter at the base of the shoots under a thick covering of wood, and can be found there in the spring, her proboscis buried in the bark of the shoot. She lays a number of eggs here, and these hatch out into larvæ, and the irritation caused by their feeding at the bases of the young leaves

gives rise to a gall formed by the young leaves swelling up at their bases, the young larvæ becoming enclosed in chambers within it. The larva grow to full size here, and by the time the gall is ripe in the summer they have acquired wings, and when liberated spread over the plant. The effect of this gall is to cripple the shoots The insects which leave the galls are winged females, and a certain number of them migrate to another food plant, upon which they lay their eggs, which are covered with a cottony deposit. The males, which appear in the autumn only, pair with the females, and from the sexually produced eggs laid arise the stem mothers. The stem mother from the portion of the generation which flew to the second host plant lives through the cold weather under the bark and appears in the spring. The larvæ arising from the eggs she lays spread over the shoots and feed upon the juices of the needles, and winged individuals from these finally return to the first host plant. Thus we have two generations of the same insect feeding at different times on two different host plants and we get the phenomenon known as parallel series.

In Europe a well-known instance of this is provided by the insect *Chermes abietis-caricis* which forms the well-known pseudo-galls upon the spruce during one of the generations or series, whilst the other is spent upon the larch. In the N.-W. Himalayas the writer has studied an allied species which he has provisionally named *Chermes abietis-picear*, which, whilst resemblling its European confrere in forming pseudo-galls upon the spruce, migrates subsequently to the silver fir, as the larch is not found in these forests.

FAMILY ALEURODIDÆ.

These are minute insects with mealy wings, seventeen-jointed antennæ and two-jointed feet terminating by two claws and a third process. Little is known about them at present in India.

In some cases they form scales upon plants, as in the case of the *Coccidæ* (*vide* below). An insect named *Aleurodes eugeniæ* has been reported as infesting *Eugenia jambolana* trees in Poona in this way.*

MONOMERA.

Tarsi consist of a single joint only.

FAMILY COCCIDÆ (SCALE INSECTS).

The form in which these insects are most usually known is that of a small scale or shell-like body closely adhering to leaves, fruits, or to the bark of trees, shrubs, &c. The scales thus formed are of the most varied form, so that no general description can be given of them. The scale may be defind as an accumulation of excreted matter, combined with the cast skin or skins of the insect covering the body either totally or partially, and thus acting as a

* For a fuller account *vide* Departmental Notes on Insects which Affect Forestry, No. 1, p. 132. † *Ibid* No. 2, p. 135.

shield under which the subsequent development takes place. All coccids do not form scales, but the habit of excreting a large quantity of matter to the outside of the body is universal. The insects are usually minute with but a single claw to the foot. The male has one pair of wings, but no mouth parts; the female is wingless and usually so degraded in form that most of the external organs and appendages cannot be distinguished. When first hatched they are tiny little creatures, and it is only later on that the females lose the power of locomotion, although in certain forms the females do not lose their antennæ and legs. They have no distinction between head and thorax. The beak is three-jointed. It is as they approach the adult stage that they become stationary and their bodies swell up and legs diminish, and the excretions forming the scales are produced. The eggs are generally laid under the body of the female, and as she lays them her body gets thinner and dries up, forming a kind of dish-cover over them, above which are the cast skins of the moults, and above these the encrustations of the scale. When the male larvæ change, they change to a pupal stage which is exceptional amongst *Hemiptera*. In spite of the female being wingless these insects spread more and cause more damage than any other family of insects. The ability to spread depends upon the activity of the larva and on the facilities which exist for the transport of the eggs. Many of these, which are often laid inside cottony masses, are blown about by the wind, others are transported by birds, &c. Cocoanut palms in the Laccadive Islands, areca palms on the Bombay coast, and coffee bushes in Southern India and Ceylon are known to suffer to a serious extent from the attacks of *Coccidæ*, whilst mango and orange trees, tea bushes and other plants have been reported as harbouring various species.

Information as to the atttacks of coccids in the forest is at present very defective in India. A genus by name *Monophlebus* has within the last two years come to the front as containing serious forest pests. The life-history of one of the species, a new one named recently by Mr. E. Ernest Green as *Monophlebus stebbingi* has been to some extent worked out, and the observations noted have shown that this class of scale has serious destructive capabilities when it swarms in large numbers. During the last few years this coccid has swarmed in ever increasing numbers in the Siwalik sal forests and adjacent areas both to the west of the Jumna and east of the Ganges. Its life-history as far as at present known is as follows:—

The young female larva first appears upon the sal leaves during November as a minute yellow speck. This increases in size, and during February it quits the leaves and takes up its position on the twigs. By the end of March it has grown into a fat, robust scale, half an inch or even as much as $\frac{3}{4}$ in length, by $\frac{1}{4}$ or $\frac{1}{3}$ in breadth, and covered with a white powdery substance, the colour beneath being orange or brown. The plate accompany-

ing this number shows these insects feeding upon a sal sapling. The female is sexually mature about this time. During the whole of this period it retains possession of its legs and antennæ and walks about over the largest trees, but spends most of its time with its beak firmly embedded in the bark of the twigs and smaller branches, from which it sucks up the sap. It is also to be found in numbers on the upper portions of saplings. The scales are sometimes so thick on the stems and branches as to entirely cover the twigs, which appear as if encrusted with snow. During the whole of this period they exude enormous quantities of a saccharine solution, which coats the leaves and twigs, clogging up the stomata, and drops down on to the parts of the tree below, thoroughly wetting them and the ground beneath. When the insects are numerous this excretion can be heard pattering down like rain drops, and soaks everthing. The male larva has not yet been found, but the male pupa is known and the male adult, which is a small red fly with a pair of black wings and some appendages at the end of its body. It is $\frac{1}{8}$th inch in length with a wing expanse of $\frac{1}{2}$ an inch. It fertilises several females and the eggs are laid by the female in cottony sacs in crevices in the bark of the trunks and beneath fallen debris on the ground. They are crimson in colour and shining, and one female lays over 450 of these in the sac.

The damage done by the pest is serious, as young twigs and smaller branches dry up under the many tappings to which they are exposed, the crowns of the trees thus being thinned out saplings similarly suffer severely. Other species and varieties of monophlebus have been found upon sissu, teak, mango and *Prosopis spicigera*, but their life-histories have yet to be worked out.

Amongst useful species the lac insect, *Carteria lacca*, which secretes both wax and dye, the lac being poured out by glands on the back, must be mentioned. It lives upon the dhak, ber, pipal, kusum and other trees. The cochineal insect is another coccid which secretes a valuable dye.

USEFUL HEMIPTERA.

The family *Pentatomidæ* contains the soldier bug, an insect which is useful in India, as it destroys caterpillars. The *Reduviidæ* are predacious upon insects and probably destroy numbers of injurious forms. The Chinese insect wax (*Fulgoridæ*) was at one time a very valuable insect, as from it a large trade in wax candles sprang up, the world's markets being largely supplied from this source. It was thought at one time that the white insect wax (*Ceroplastes ceriferus*) of India would be utilizable for the same purpose, but its wax proved to burn with too smoky a flame, and the general introduction of kerosine caused the experiments being made with it to be given up. Its only use at present is that it is eaten when found by villagers. As already mentioned, there are

two extremely useful insects in the family. The lac insect (*C. lacca*) secretes both a wax and a dye. The insect feeds upon the dhak (*Butea frondosa*), the ber (*Zizyphus jujuba*), pipal (*Ficus religiosa*), kusum (*Schleichera trijuga*), babul (*Acacia arabica*) and numerous other forest trees. It yields two crops in a year, the lac encrusting the twigs in large deposits, and forming a valuable article of forest produce, the world's supply being supplied from India.

The cochineal (*Coccus cacti*) secretes a valuable dye. An inferior variety in India lives upon the Opuntia (prickly pear).

The Monophlebus Scale Insect in the Kheri Sal Forests.

In his excellent "Notes on a tour through the Kheri Division, Oudh," in the May number of the *Indian Forester*, H. J. makes some remarks anent the dying back of the young sal saplings for some years after first germination from the seed. He also alludes to the periodic drying up and replacement of the leading shoot by extra vigorous side-shoots.

H. J. goes carefully through the possible causes of these two serious drawbacks to rapid regeneration and gradually eliminates clear and forceful reasoning the many reasons to which such might be attributed. Suppression from want of sufficient direct sunlight, failure to tap the permanent water-supply and consequent scorching by the dry winds of the hot season, frost, fires, grazing and injuries by men and other mammals—all are dealt with in turn and repudiated as unsatisfactory, since in every case examples where these causes could not be attributed are to be found in the areas under consideration. There remain insect attacks. The writer of the note says: "The scale insect swarms in the sal forest at certain times of the year, but so far no connection has been proved between its ravages and this habit of the sal tree. Common as it is, it is hardly credible that this insect should be so universal that no part of the forest should ever be left undamaged by it."

The scale insect here alluded to I take to be the *Monophlebus* so common during the last few years in the Siwalik sal forests. I would therefore draw the attention of H. J. to the note upon this insect in 'Departmental Notes on Insects that Affect Forestry,' No. 1, p. 140 (as also to pp. 274-275 of the present number). It is there distinctly stated that the drying up of leading shoots and dying down of saplings and the drying up of twigs and smaller branches upon old trees is attributed to this scales. Since the observations were made upon which that note was writtten the writer has had the opportunity of spending a month in the Dun Forests in April, May (1902), the period when this scale's attack culminates; and anyone who has done this once in a year when the infestation is particularly severe will have little doubt as to the cause of the dying of young trees or drying up of

* We regret that we are unable to reproduce this diagram, but it appears to carry out Mr. Coventry's contention.—Hon. Ed.

leading shoots. When one remembers that from early in February on to the end of April the scales confine themselves entirely first to the young twigs, subsequently moving down, as they increase in size, on to the older ones, or in the case of a sapling shifting lower down the shoot, and that during the whole of this period they are continually tapping the twig, branch, or shoot, one can scarcely be surprised at these latter drying up. If H. J. systematically bled the leader of a healthy sal sapling, through the months when it was starting the new growth of the year and was full of sap, he would not be surprised at the top dying. And yet this is just what is taking place in the forest under the action of the scales. Further, the insects excrete during the whole of this period large quantities of a sugary material, which coats leaves, twigs, branches and shoots with a film which dries like varnish under the sun's rays, clogging up the stomata and pores, and thus interfering with respiration. The photograph depicted here is one of a young sapling taken by Mr. Milward in April 1901, when we were inspecting the scale attack in the Sabbhawala forest in the Dun. It shows the fully developed scale insect (over half an inch in length, oval, thick and fleshy) clustered in a serried mass for several inches on the lower part of the leading shoot. Earlier in the year the coccids would have been found near the summit. As they increased in size they moved down to the lower portion of the leader. The shoot thus dries up from the top downward. Mr. E. M. Coventry has noticed this to occur in the Kalesar forest on the western bank of the Jumna River. (*vide* D. N. 1, 140). I would not however be understood to make the sweeping statement that the scale is the sole cause for the lamentable state of affairs in these sal forests. We require a careful series of experiments to be carried out on sample plots through a number of years before such a statement could be made. The damage may however be entirely due to insects nevertheless. In the Dun the scale is apparently at times accompanied by another serious pest. This is a looper caterpillar, the larva of *Boarmia selenaria*, a moth of the family *Geometridæ*. It is a large caterpillar, which attains its full growth at the end of April. It spends several weeks feeding upon the sal, and is excessively voracious, eating down leaves, inflorescences, and all the green shoots of the year. I have seen young saplings from which every particle of green had been devoured, and this just after they had developed their spring foliage. Mr. Milward and the writer noted in 1901 that in a number of instances the scale and looper were present on the tree in about equal numbers. In the photograph these looper caterpillars will be seen at the top of the sapling from which they had stripped nearly all the green growth. At the time the photograph was taken they were engaged in eating down the remaining green shoots on the young tree. Young saplings attacked in this way by these two pests in the spring growing season were found, on being visited in the following September, standing black and

S.B. Mondul del. From a Photo by R. C. Milward.

MONOPHLEBUS STEBBINGI, GREEN, AND BOARMIA SELENARIA, HÜBN ON A SAL (SHOREA ROBUSTA) SAPLING.

gaunt in the forest; the complete defoliation and heavy tapping *to which they had been subjected in the spring* had so reduced their vitality that they were quite unable to produce a second flush. As a result of that severe attack of these two insects many young saplings undoubtedly died down. As neither of these pests attack the roots so far as we at present know, these latter would remain unaffected, and the succeeding year would send up a fresh shoot. Further study will, I believe, show that this looper has a *second or rains generation in the year* which attacks the second flush of leaves. We believe that the *Boarmia* is present in the Kheri sal forests. In Hampson's Moths in the Fauna series its distribution *is given as general throughout India.* With reference to the adaptability of spreading possessed by this scale I may add that each of the fat white insects, which are the females, *is capable of laying over 400 eggs** *(475 is the largest number* yet counted as laid by one insect). With such remarkable powers of reproducing itself it is scarcely surprising that in favourable seasons it swarms in such large numbers.

From the above remarks I think it will be considered as more than possible that *the state of the young sal in the Kheri forests may be due to insect attacks.* A few dry years, whilst lowering perhaps the vitality of the tree, would favour the increase of its insect aggressors.

This question, whilst being a most interesting one scientifically, is at the *same time* one of such sylvicultural importance that we trust divisional officers in charge of the N. W. Sal areas will look at it from the point of view to which H. J. has drawn attention and study the action of these two pests both generally over their whole forests and more closely in small specially selected areas.

Grass for Paper Manufacture.

Major Prain, I.M.S., has very kindly identified for us the grasses alluded to by M. G. Thompson in his letter in the last (June) number of the Magazine.

The one resembling sabai or bhabar grass (*Ischæmum angustifolium*) is *Pennisetum Alopecurus* Stend. The Bengal Paper Mills Company have reported it to be equal to average Sahebgunge sabai grass.

The second grass sent, which Mr. Thompson thinks might form a useful fodder grass, Major Prain has identified as *Paspalum scrobiculatum* Linn. var. *Kora.*

These grasses would seem to be both worthy of attention with a view to their inclusion amongst the exploitable minor products of the areas over which they grow.

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* *Vide* Departmental Notes on Insects that Affect Forestry, No. 2, p. 318.

Indian Pheasants and their Allies.

BY F. FINN, B.A., F.Z.S.

(*Continued from page* 210.)

CHAPTER VII.

THE FRANCOLINS AND SPUR-FOWL.

THE partridges to which the above names are applied form two very distinct groups, the spur-fowl in particular being very easily recognizable. They are smallish birds, quite partridges in size, but with longer tails than partridges usually have, and as they sometimes raise these in a folded form, they remind one much at such times of small bantam fowls, their resemblance to these being increased by the bare red skin which, as in fowls, surrounds their eyes. The cocks are always quite different in plumage from the hens, and have two or three spurs on each leg, the hens having one, two or none.

The birds are perhaps just as much miniature Jungle-fowl as Partridges, but they have not the hackle or long tail of the Jungle-cocks, so that they may as well be classed with the partridges as anywhere else, the various groups of the pheasant family being inter-related in such a complex way that it is quite impossible to arrange them naturally in a line, so to speak—a difficulty which besets all classifications.

The Spur-fowl are only found in India and Ceylon, three species being known; they all keep much to cover and are difficult to flush.

THE RED SPUR-FOWL.

Galloperdix spadicea, Blanford, Faun. Brit. Ind. Birds, Vol. IV., p. 106.

Native names:—*Chota jungli murghi*, Hind. in Central Provinces; *chakotri*, *kokatri*, Mahrattas in the Syhadri Range; *kustoor*, Mahrattas of the Deccan; *sarraoa koli*, Tamil; *yerra-kodi*, *jitta-kodi*, Telugu.

The general colour of the male of this species is chestnut the female being mottled black and buff; the legs and base of the bill are red, as well as the naked skin round the eyes.

The cock is about fourteen inches long, with a six-inch tail, and wing exceeding this by half an inch; the bill from gape is an inch in length, and the shank nearly twice this. The hen is a little smaller.

This Spur-fowl inhabits the base of the Himalayas in Oudh, and is found in the peninsula south of the Indo-Gangetic plain wherever the locality is suitable, for it avoids cultivated and open country, frequenting hilly forest land.

It varies a good deal in plumage, birds from Mount Abu and the neighbourhood being paler, especially the females, in which the black pencilling on the back is very scanty, and the ground-colour pale and greyish. About Matheran and Mahableshwar also hen birds are very lightly pencilled, although the ground-colour is as rich as in typical specimens.

This bird is shy and often solitary, a great runner, and seldom seen on the wing; the call of the male is said to be well imitated by the Mahratta name *kokatri*, being a kind of crow; the general note is a harsh cackle. It breeds between Februaıy and June, and possibly again towards the end of the year; three to seven eggs are laid, of a buff or greyish colour. If is good eating in the cold weather, but requires hanging a few days.

THE PAINTED SPUR-FOWL.

Galloperdix lunulata, Blanford, Faun. Brit. Ind. Birds, Vol. IV., p. 108.

Native names:—*Kaingir*, Uriya; *Askaol*, Orissa and Singhbum; *Hutka*, Gond in Chanda; *Kul-koli*, Tamil; *Jitta-kodi*, Telugu.

This bird is slightly smaller than the last, the male being little over a foot in length; it also shows very little red round the eye. Its colour however makes it easily distinguishable from any other partridge-like bird. The general colour is chestnut, with white black edged spots, the head is speckled with black and white, the crown being glossed with green, the shoulders are also dark glossy green, the tail is green-black and the breast buff with black spots.

The hen is of a uniform sooty brown, with the head mostly chestnut. The bill and feet are dusky in both sexes, not red as in the other species. This beautifully-marked bird especially affects rocky hills, and is somewhat locally distributed. It appears not to occur at all on the Malabar Coast, nor in North-Western India, nor is it found in the Bombay Presidency north of Belgaum, nor anywhere north of the Ganges. Although it occurs in some parts of the Red Spur-fowl's territory, it does not extend so far to the west or north. Its breeding season is from March to May, and the eggs, which are glossy and pale drab in colour, do not exceed five in number.

THE CEYLON SPUR-FOWL.

Galloperdix bicalcarata, Blanford, Faun. Brit. Ind. Birds Vol. IV., p. 109.

Native names:—*Haban* or *Saban-kukula*, Cingalese. In size this bird is intermediate between the last two but has a shorter tail than either of them.

The cock has a speckled appearance, being streaked above and on the flanks with white on a black ground; the neck in front

is white with black edgings and the breast pure white, the rump is chestnut, and there is an intermixture of this colour on the shoulders; the tail and most of the wings are black and the lower part of the belly dark brown with pale spots.

The hen is of a dull chestnut brown, and both sexes have red *bills and feet as well as a* red space round the eye.

This is the only Spur-fowl found in Ceylon, and it is confined to that island. Even there its range is not universal, for it is absent from the dry northern portion. Being, like the rest of the group, an inveterate skulker, and having a cackling note, it is more often heard than seen. It breeds from April to August, the eggs being cream-coloured, and usually only four in number.

The Francolins are a numerous group of partridges mostly found in Africa; five species are, however, Indian, and these include the most widely-spread and best known of our partridges. They are of the typical partridge form, with tails of meduim length, and no bare skin about the eye. In all the cocks differ from the hens either in plumage or by possessing spurs; these are always absent in the hens. The Francolins are inclined to affect cultivation, and are the best of our partridges for sporting purposes.

The commonest of all is—

The Grey Partridge.

Francolinus pondicerianus, Blanford, Faun. Brit. Ind. Birds, Vol. IV., p. 139.

Native names:—*Titar, Ram titar, gora titar, safed titar*, Hind. *khyr*, Bengali, Uriya; *Gowjal huki*, Canarese; *kondari*, Tamil; *Kawunzu*, Telugu; *Oussa* and *watuwa*, Cingalese.

Both sexes are alike in colour in this species; the upper parts are brown, boldly pencilled with dark-edged, creamy white bars, and the lower buff with fine dark transverse pencilling; the throat is buff surrounded by a broken blackish band, and the outer tail feathers chestnut. The bill is dark grey, the eyes dark, and the legs dull red. The cock is distinguished from the hen by being slightly larger and by having a sharp spur on each leg.

The cock is just over a foot long, with the wing nearly six inches, and the shank about an inch and a half.

This bird is found almost all over India, but it avoids swamps and thick forest, and does not usually ascend hills to a higher level than 1,500 feet. It is absent from Lower Bengal and from the Malabar Coast south of Bombay; and it is not found east of India. Westwards, however, it ranges as far as the Persian Gulf. It is most abundant where cultivation is interspersed with bush jungle, and its harsh shrill call, beginning with single notes, and continued in trisyllables, is familiar to every one, for it is as well known in towns as in the country, being a favourite cage bird

with the natives. Some of these latter like the note, but the great reason for keeping partridges is the sport they afford as fighting birds. So pugnacious are they, that I have seen two birds let out of their cages near a lawn which had no idea of "going to grass," but flew at each other straightway; and they are commonly caught by putting out a tame cock in a cage garnished with nooses, in which his wild assailants are caught. To make him call and challenge them, he is blown upon, an act which excites him to the greatest fury. Many birds also, at Calcutta at any rate, are brought in as mere chicks, and brought up by hand. It may be such specimens are the very tame ones one sees following their owners like so many little dogs, when let out; but possibly this partridge, like the chukor, can be easily tamed when adult. Double-spurred birds now and then occur, and are naturally preferred by the natives for fighting, but I have never seen such a one.

For ordinary sporting purposes, amongst Europeans, this partridge is not much esteemed; it is hard to flush, being an inveterate runner, and when you have got it is apt to be dry and flavourless. The best time to get it in good condition is in the early part of the cold weather. It has a very bad reputation as a filthy feeder, but both Pea-fowl and Jungle-fowl, when found near villages, are not by any means blameless in this respect, so that very possibly the humble grey is not so very much worse than his betters in this respect.

The breeding season of this bird is an extended one, for while they usually go to nest between February and June, many breed a second time between September and November; the eggs are brownish white, and six to nine form the clutch.

THE SWAMP PARTRIDGE.

Francolinus gularis, Blanford, Faun. Brit. Ind. Birds, Vol IV., p. 141.

Native names:—*Kyah, Khyr, Kaijah*, Bengali; *Koi, Koera*, Assamese; *Bhil titar* of the Cacharis. Formerly sometimes erroneously called the *Chukore*.

This species is easily distinguished from most of our partridges by its large size and comparatively long legs; as in the last species, the sexes are alike in plumage, but the cock is easily distinguishable by his spurs. The upper plumage is brown barred with buff, and the outer tail feathers chestnut, as in the grey partridge; but the throat is bright rust-red, and the rest of the underparts brown longitudinally streaked with white, so that the effect is very different. The bill is blackish, the eyes dark, and the legs dull red.

The cock of this species, which is a little larger than the hen, will measure fifteen inches, though his tail is only a little over four; the wing is more than seven inches, and the shank measures two and a quarter.

The Swamp Partridge, as its name implies, has a quite different habitat from our other species, affecting high grass and cane-brakes near the edges of rivers and jheels, though it will come into cultivation to feed. It haunts the alluvial plains of the Ganges and Brahmaputra, extending from Pilibhit to the extremity of Assam and Cachar, and even occurs occasionally on the Khasi plateau; it is, however, absent from the Sundarbans. Very little is known about its breeding, but on two occasions five eggs belonging to the species have been taken in April; they were cream coloured and slightly speckled.

Owing to the localities which it frequents, the Swamp Partridge is usually shot from elephants; but Dr. Blanford states that he has shot it on foot near Colgong, in grass only three or four feet high. He states that it much resembles the common grey partridge in its edible qualities, as it also does in its call; and it is equally pugnacious. Mr. Hume, in the 'Game Birds of India,' falls foul of his artist for representing this species standing in water like a wading-bird. No doubt the draughtsman represented it thus in ignorance; but it would be interesting to know if this, one of the very few swamp-haunting birds in the Pheasant family, ever does go voluntarily into water in the wild state. The keeper of the aviary in which this species was confined in the London Zoo told me that he had seen it standing in water, and the white-winged Pheasant (*Phasianus principalis*) which inhabits the Bala-Morghab river's reed-beds, is known not only to wade but to swim, if necessary.

THE BLACK PARTRIDGE.

Francolinus vulgaris, Blanford, Faun., Brit. Ind. Birds, Vol. IV., p. 135.

Native names:—*Kala titar*, Hind., *Kais-titar* (the female) Nepal; *Tetra*, Garhwal; *Vrembi* of the Manipuris.

In this species the cock is spurred, and his plumage differs conspicuously from that of the female. His general colour is black with a long white patch on each side of the face, large white spots along the sides, and close white barring on the lower part of the back and the tail. There is a chestnut collar round the neck, and a patch of the same colour under the tail; the shoulders and most of the wings are brown marked with buff, the markings following the edge of the feather; the quills are barred with buff. The belly is pale chestnut marked with white; the crown streaked light and dark brown.

The hen is somewhat like the cock above, but the barring of the back and tail is coarser, and brown and buff instead of black and white. She shows no black on the head or below, and no chestnut on the neck except at the back. She has the eyebrows and sides of the head buff, the throat nearly white, and the rest of the lower parts buff irregularly pencilled with brown.

Young cocks are more spotted with white than the old birds, and young hens also are spotted on the breast, not pencilled like old ones.

The bill is black in the cock and dark brown in the hen; the eyes dark and the legs orange-red in both sexes.

The sexes both vary in size, but the cocks are the largest; one will measure about thirteen and a half inches, with the tail four inches and the wing just over six; the shank about two.

The Black Partridge with us inhabits Northern India from Sind to Manipur; its southern boundary runs south of Cutch and north of Kattywar, and thence to the Chilka Lake in Orissa. To the northward it ascends the outer slopes of the Himalayas, following the river valleys to about five thousand feet; Manipur is its eastern and southern limit, but it has a wide range to the west of India, ranging through Persia and Asia Minor even to Cyprus. It formerly inhabited Greece, Italy, Sicily and Spain, and appears to have been the bird known to the Greeks and Romans as *Attagen*, and was much esteemed for the table. It has, however, become extinct in these western countries, and is evidently a bird which needs careful preservation. This it well deserves, as it is an excellent sporting bird, and very good eating; in fact, one of the most desirable of all partridges. Its stronghold in India is the Indo-Gangetic plain and the regions adjacent; it especially affects high grass and tamarisk scrub near water and cultivation, and often cultivation itself. It is generally met with singly or in pairs. The male has a terribly harsh call-note or crow, which he is fond of uttering from an anthill. There is a pretty native legend which renders the call as "*Subhán, teri kudrat,*" but I have never been able to fit these pious words to it, or any others. The Black Partridge breeds from May to August, most nesting in June: the eggs are fairly numerous, six to ten *in a clutch, and drab in colour.*

THE PAINTED PARTRIDGE.

Francolinus pictus, Blanford, Faun. Brit. Ind. Birds, Vol. IV., p. 137.

Native names:—*Titar, kala itar*, Maharatta; *kakhera kodi*, Telugu.

In this species neither sex possesses spurs, and the hen and the cock are much alike, though not indistinguishable. It is rather smaller than the Black Partridge. The cock is not unlike the male of the Black Partridge above, but very different below, being so heavily spotted with white that there is only enough black to separate the spots; there is no chestnut collar round the neck, *but the eyebrows, face, and throat are* chestnut. In the hen the throat is whitish, and the bars on the

back are buff, and wider apart than in the cock. The bill is blackish, the eyes dark, and the legs orange-red.

This bird occupies a territory south of the Black Partridge's, the southern limit of that bird being the northern frontier of the painted species; this becomes rarer towards the south, and is absent from the Malabar Coast south of Bombay, as also from Mysore. Nor is it found in the Peninsula south of Coimbatore, although occurring in Ceylon on some of the hills west and south of Newera Eliya. It is not found east or west of India. It meets the Black Partridge on the boundary of that species, and hybrids between the two are occasionally found. Its general habits and its qualifications as a sporting bird and table delicacy are much the same as those of the Black Partridge, and it may be regarded as one of our most desirable game birds. It is more often found in cultivation than the other species, and also more frequently found in dry grass land at a distance from water, so that it would appear to be of a more adaptable nature. Another detail of its habits which differs from those of the other species is its partiality for perching on trees, whence the male frequently calls; he has a different and less harsh note. Its nest and eggs are much like those of the Black Partridge, but it seems to breed somewhat later.

THE EASTERN OR CHINESE FRANCOLIN.

Francolinus Chinensis, Blanford, Faun. Brit. Ind. Birds, Vol. IV., p. 138.

Native name: -*Kha*, Burmese.

This species is intermediate in size between the black and the painted francolins; the sexes differ in colour nearly as conspicuously as those of the black species, and the male only possesses spurs. The general colour of the cock is black spotted with white, these spots becoming broad bars on the belly. The top of the head is brown with pale edges and black forehead and eyebrows; there is another black band from the corner of the mouth to below the ears, and between this and the eyebrow a white streak covers the side of the face, the throat being also white. The lower back is black with close narrow white bars; under the tail is a chestnut patch, and the shoulder feathers and innermost wing quills are edged with chestnut and have the spots buff.

The hen is brown above, with a pale mottling; the lower back is barred with buff and brown; the chin and throat dirty white, and the underparts below this buff barred with dark brown, and plain chestnut under the tail. On the head the eyebrows and cheek-stripes are brown, and the light band buff. The beak is dark brown, eyes light hazel, and the legs orange.

This Francolin is found, in our limits, only in certain parts of Burma, and in Karennee. It is common in certain localities north of Prome in the Irrawaddy valley; it has also been obtained in Toungoo and the Thounggyen valley. Outside Burma it inhabits South China, Cochin China and Siam. Its general habits resemble those of the two previous species; it haunts forest clearings and waste land, and is also found in bamboo jungle. In Burma it breeds in June and July; as many as eight eggs may be laid, and they are pale buff in colour.

(*To be continued.*)

VI.—EXTRACTS, NOTES, AND QUERIES.

"Spike" in Sandal Trees.

I READ your interesting article on "Spike" disease in sandal some weeks ago. May I venture to say something about it in your valuable paper. I have read with great interest Mr. Barber's Report on the above subject in the *Indian Forester*. Some very interesting experiments might be tried and noted. I have been stationed in this Taluq (Hunsur) for 1½ years, and have noticed the alarming extent the spike disease has taken hold of the sandal. In Mr. Barber's Report in the *Indian Forester* he quotes Mr. McCarthy, who says that the spike disease "originally came from Mysore in to Coorg." This I beg to differ from, because near the Coorg boundary the disease seems to me worse than towards the east. True, just outside the town of Hunsur the disease has got a thorough hold of the trees, but how far east this spike disease extends I cannot say. I would be very much obliged to some Forest Officers in the Mysore service who would give me some data on this subject in their respective districts. Mr. Barber seems to be in some doubt whether sandal trees with the disease produce flower and fruit. I say they do, as I have seen it. I hope to get photographs of it, and if Mr. Barber would care to see them I will very gladly send him a copy.

Another interesting thing I tried was how long sandal trees with spike live. In August last I marked three trees which were all in a line about 15 feet apart. I marked the trees as follows:— Nos. 1, 2 and 3. No 1 tree had the disease when I marked it, No. 2 had *just* begun spike. Nos. 1 and 3 were on the left and right and No. 2 was in the centre. From time to time I used to inspect these trees and watch their progress. Some time in November I inspected these trees again, and found No. 1 tree was dying fast. No. 3 the disease was spreading rapidly all on the tree. No. 2 tree no spike, but dying in a different way. On the 1st February I had a look at them again, with the result that No. 1 tree was found quite dead, No. 3 tree in a very bad state,

No. 2 tree dying, but still with no appearance of spike. How can Mr. Barber account for No. 2 tree not getting spike? Just before writing this I had a look at Nos. 2 and 3 trees (No. 1 I had dug up). No. 3 tree is all but dead, and I would venture to say that it will be quite dead by the middle of next month. No. 2 tree has no appearance of spike as yet. So in this individual case the life of this tree, since it started getting spike, is eight months. I hope to try this experiment in other localities in this range so as to strike an average to find out the length of time they live after once getting the disease.

As regards Lantana having anything to do with spike is, I think, doubtful, as for instance, in a certain gentleman's compound here, where Lantana has never been known to exist, certain sandal trees have been watched by him from time to time. There is certainly an appearance of spike on them. I don't think any one can say for certain now that Lantana is the cause of this.

Is spike a new disease? Sandal has been in existence for years and years in the Mysore Province. The disease may have existed some time or other, but whether it did or not, it is of a very virulent type at present. Some one laughed at me at the idea of having mentioned this subject, and said that the disease must have been going on for years and yet there is sandalwood to fill our *koties* with. Let that be as it may, but if any one would care to come round with me I will show them what havoc the disease is doing at present. Trees of all sizes, except saplings, get it, but at what age it makes its appearance, I would not venture to say.

The question now is, what is to be done to check the spread of the disease? In Coorg I believe they uproot all sandal trees with the first appearance of spike. It is all very well to do this in Coorg, where the area of sandal is not great, but in Mysore it is of a very different matter. Sandalwood is *the* chief source of revenue for the Mysore Forest Department, and I think the Mysore Government should go in to the matter at once and see what can be done. I think it is of a far more serious matter than some people think. Young trees die off in hundreds with no heartwood and are only useful for firewood. If this be the case, how long will sandal last at the present death-rate?

P. E. BENSON, in *Indian Planting and Gardening.*

HUNSUR.

President Roosevelt on Forestry.

On the 26th March last the versatile President of the United States found leisure to lecture before the Society of American Foresters at Washington on "The Importance of Practical Forestry."

His lecture forms a clear and concise statement of the value and the aims of scientific forestry, and as such may be read with as much edification in India as on the spot where it was delivered. After laying down the theorem that the forest policy of any country must be an essential part of his land policy, Mr. Roosevelt went on :—

First and foremost, you can never afford to forget for one moment what is the object of the forest policy. Primarily that object is not to preserve the forests because they are beautiful, though that is good in itself; not to preserve them because they are refuges for the wild creatures of the wilderness, though that, too, is good in itself; but the primary object of the forest policy, as of the land policy, of the United States is the making of prosperous homes. It is part of the traditional policy of home-making of our country. Every other consideration comes as secondary. The whole effort of the Government in dealing with the forests must be directed to this end, keeping in view the fact that it is not only necessary to start the homes as prosperous, but to keep them so. That is where the forests have got to be kept. You can start a prosperous home by destroying the forest, but you don't keep it prosperous.

And you are going to be able to make that policy permanently the policy of the country only in so far as you are able to make the people at large, and above all the people concretely interested in the results in the different localities, appreciative of what it means. Give them a full recognition of its value, and make them earnest and zealous adherents of it—keep that in mind, too. That is the only way in which, permanently, this policy can be made a success. In other words, you have got to convince the people of the truth, and it is the truth, that the success of homemakers depends in the long run upon the wisdom with which the nation takes care of its forests. Now, that seems a strong statement. It is none too strong. There are small sections of this country, as of every country, where what is done with the woodland makes no difference; but over the great extent of the country the ultimate well-being of the homemaker is going to depend in a very large part upon the intelligent use made of the forests. Now, in other words, you yourselves have got to keep this practical object before your mind. You have got to remember that a forest which contributes nothing to the wealth, progress, or safety of the country is of no interest to the Government, and should be of little to the forester. Your attention must be directed not to the preservation of the forests as an end of itself, but as a means for preserving and increasing the prosperity of the nation.

"Forestry is the preservation of forests by wise use," to quote a phrase I used in my first message to Congress, and keep before your minds that definition, that forestry is the preservation of forests by wise use; not by abbreviating the use, but by making

the forest of use to the settler, the rancher, the miner, the man who lives in the neighbourhood, and, indirectly, the man who may live hundreds of miles off down the course of some great river which has had its rise among the forest-bearing mountains.

The forest problem is in many ways the most vital internal problem of the United States. The more closely this statement is examined, the more evident its truth becomes. In the arid region of the West, agricultural prosperity depends first of all upon the available water supply. Forest protecion alone can maintain the stream flow necessary for irrigation in the West, and can prevent the great and destructive floods so ruinous to communities farther down the same streams that head in the arid regions.

The relation between the forest and the whole mineral industry is an extremely intimate one, for, as every man who has had experience in the West knows, mines cannot be developed without timber, usually not without timber close at hand. In many regions through the arid country ore is more adundant than wood, and this means that if the ore is of low grade, the transportation of timber from any distance being out of the question, the use of the mine is extremely limited by the amount of timber available close at hand.

The very existence of lumbering of course—and lumbering is the fourth great industry of the United States—depends upon the success of your work, of our work as a nation, in putting practical forestry into effective operation.

As it is with mining and lumbering so it is in only a less degree with transporation, manufactures, commerce in general. The relation of all of these industries is of the most intimate and dependent kind to forestry.

It is a matter for congratulation that so many of these great industries are now waking up to this fact, the railroads especially, managed as they are by men who are obliged to look ahead; who are obliged by the very nature of their profession to possess a keen insight into the future have awakened to a clearer realisation of the vast importance of economical use both of timber and of forests. Even the grazing industry, as it is carried out in the great West, which might at first sight appear to have little reference to forestry, is nevertheless closely related to it because great areas of winter range, ranges available and good for winter grazing, would be absolutely useless without the summer range in the mountains where the forest reserves lie.

As all of you know, the forest resources of our country are already seriously depleted. They can be renewed and maintained only by your co-operation, by the co-operation of the forester with the lumberman, with the practical man of business in all his types, but above all, with the practical man of business

whose profession is lumbering. And the most striking and encouraging fact in the forest situation is that lumbermen are realising that practical lumbering and practical forestry are allies, not enemies, and that the future of each depends upon the other. The resolutions passed at the last meeting of the representatives of the lumber interests, which occurred here in Washington, were a striking proof of this fact, and a more encouraging feature of the present situation. As long as we could not make the men concerned in the great lumber industry realise that the foresters were endeavouring to work in their interests, and not against them, the headway that could be made was but small, and we will be able to work effectively and bring about important results of a permanent character largely in proportion as we are able to convince those men, the men *at the head of that great profession*, of that great business, of the practical wisdom of what the foresters of the United States are seeking to accomplish.

The last analysis, the attitude of the lumberman toward your work, will be the chief factor in the success or failure of that work. In other words, gentlemen, I cannot too often say to you—as, indeed, it cannot be too often said to any body of men of high ideals and good scientific training who are endeavouring to accomplish work of worth for the country—that they must keep their ideals and yet seek to realise them in practical ways. The United States is exhausting its forest supplies far more rapidly than they are being produced. The situation is grave, and there is only one remedy. That remedy is the introduction *of practical* forestry on a large scale, and of course that is impossible without trained men—men trained in the closet and by actual field-work under practical conditions. You have created a new profession—a profession of the highest importance, a profession of the highest usefulness toward the State; and you are in honour bound to yourselves and to the people to make that profession stand as high as any other—as the profession of law; as the profession of medicine; as any other profession most intimately connected with our highest and finest development as a nation. You are engaged in pioneer work in a calling whose opportunities for public service are very great. Treat the calling seriously. Remember how much it means for the country as a whole. Remember that if you do your work in a crude fashion, if you *only half learn your profession*, you discredit it as well as yourselves. Give yourselves every chance, by thorough and generous preparation and by acquiring, not only a thorough knowledge, not only the knowledge that goes deep, but a wide outlook over all the questions on which you have to touch. The profession which you have adopted is one which touches the Republic on almost every side—political, social, industrial, commercial—and to rise to its level you will need a wide acquaintance

with the general life of the nation and a view-point both broad and high. Any profession which makes you deal with your fellowmen at large makes it necessary that if you are to succeed you should understand what those fellowmen are, and not merely what they are thought to be by people who live in the closet or the parlour. You have got to know who the men are with whom you are to work, how they feel, how far you can go, when you have to stop, when it is both safe and necessary to push on. You have got to know all of those things if you are going to do work of the highest value.

I believe that the foresters of the United States will create a more effective system of forestry than we have yet seen. If not, gentlemen, if you do not, I will feel that you have fallen behind your brethren in other callings; and I do not believe that you will fall behind them. Nowhere else is the development of a country more closely bound up with the creation and execution of a judicious forest policy. This is, of course, especially true of the West, but it is true of the East also. Fortunately, in the West we have been able, relative to the growth of the country, to begin at an earlier day, so that we have been able to establish great forest reserves in the Rocky Mountains, instead of having to wait and attempt to get Congress to pay a very large sum for their creation, as we are now endeavouring to do in the Southern Appalachians.

After congratulating his hearers on the good start that had been already achieved, the President ended by saying:—

Twenty years ago a meeting such as this to-night would have been impossible, and the desires we here express would have been treated as having no possible relation to practical life. We have reached a point where American foresters, trained in American forest schools, are attacking American forest problems with success. That is the way to meet the larger work you have before you. It will be a difficult work. Which, again, is true of almost any work worth doing; it will be a difficult work, and all the more so because precedents are lacking. It will demand training, steadiness, devotion, and *esprit de corps*, fealty to the body of which you are members, a desire to keep the ideals of that body high. The more harmoniously you work with each other, the better and more effective your work will be; and a condition precedent upon your usefulness to the body politic, as a whole, is the way in which you are able to instil your own ideals into the mass of your fellowmen with whom you come in contact, and at the same time to show your ability to work in a practical fashion with them, to convince them that this is a business matter. It will be for them to co-operate with you to convince the public of that, and above all, so to convince the people of the neighbourhoods in which you work, and especially the lumbermen and the others who make their life-trades dealing with the forests.—*The Pioneer*.

Forestry.

(*From the Timber Trades Journal.*)

In the House of Commons on Tuesday night, Mr. Herbert Lewis (Flint Boroughs) urged "that it is expedient to give effect as early as possible to the recommendations of the Departmental Committee on Forestry."* There were two cardinal facts in connection with the question which, he said, deserved the attention of the House and the country. The one was that the United Kingdom paid the enormous sum of £26,000,000 for imported timber, and the other was that the country contained 21 million acres of waste land on a large proportion of which afforestation could be undertaken with satisfactory financial results. The evidence that was given to the Committee on afforestation unanimously favoured some immediate and effective provision of bringing systematized instruction within the reach of owners, agents, foresters, and woodmen. That was a cardinal point of the recommendations of the Committee, and he was glad to believe that the President of the Board of Agriculture was himself in full sympathy with the spirit of that recommendation.

Mr. Hanbury said afforestation was a very important question, in which he had taken considerable interest. When we saw how the supply of the rest of the world was gradually diminishing, and with the possibility before us of something like a timber famine in the not very far distant future, it behoved us to look more carefully than we had done in the past to our own timber supply. There was a good deal of land in the country which hardly brought in any agricultural returns, and he thought it very probable that much of that land might pay better under timber. In various parts of the country they heard about the water supply becoming very scarce, and it was quite possible that a greater growth of timber in this country might go some way to remedy even that defect. (Hear, hear.) The Departmental Committee had evidently conducted their work with the greatest possible care, but the evidence had not yet been published, and the hon'ble member had the advantage of him, so that he would not expect him to express now any definite opinion as to how far their recommendations should be given effect to. The recommendations would undoubtedly receive his very careful consideration, and if supported by the evidence he had no doubt they ought to receive the attention of the Government.

Mr. Lewis asked leave to withdraw his motion.

The motion was by leave withdrawn.

Mr. Nolan (Lough, S.) rose to call attention to the importance of this subject, when

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* *Vide* No. 4, p. 155, of this Magazine (April 1903).

Notice having been taken that there were not 40 members present, and a quorum not being formed after the usual interval,

The House stood adjourned at 11 o' clock.

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Harry Charles Hill.

By Sir Dietrich Brandis, K.C.I.E., F.R.S.

The excellent notice of my dear late friend, which appeared in the *Indian Forester* of January last, has given me great pleasure, and I wish to supplement it by a few recollections of my own.

Hill was educated at the Sutton Coldfield Grammar School. At the entrance examination for the Indian Forest Service in 1869, he was only 17 years old, and was one of the youngest who competed at that examination. Nevertheless he came out not far behind the first successful candidate, beating several men from public schools and others considerably older than himself. Hill had passed in French, and hence was among those who were sent to study Forestry in France under the arrangements which I had been permitted to make while on furlough at home in 1866. Under these arrangements the students were in the first instance sent to Haguenau in Alsace for a course of practical work under Clément de Grandprey, who was then in charge of those forests. On the outbreak of the Franco-Prussian war this work came to an end, and in August 1870 the English students were sent home, where they were employed under Dr. Cleghorn's guidance in studying Natural sciences, Hindustani and Surveying, first at St. Andrews and afterwards at Edinburgh. At St. Andrews Hill obtained the prize for Practical Chemistry, and at Edinburgh he was first in the Surveying class. The students returned to Nancy in August 1871, and completed their course there in October 1872, working steadily and without any holidays, as the ordinary course of the Forest School was of two years' duration and they had barely 15 months to do it in. At that time I was in England on my second furlough, and went to Nancy to see the students. On this occasion the Professors told me: "*Tous vos jeunes Anglais sont de bons garçons, mais Hill c'est le vrai Forestier.*" At my suggestion the Right Hon'ble Sir Mountstuart Grant-Duff, then Under-Secretary of State for India, also went to

see the English students at Nancy and he was greatly struck with Hill. whom he only met on that occasion. He retained a vivid recollection of him and has asked me to say that he was deeply grieved when he heard of his death.

After working in Oudh for two years, Hill was attached to the Forest Survey Branch, which in 1873 had been organized by Lieutenant-Colonel F. Bailey. In consultation with that officer I conceived the idea of attaching temporarily one or two professionally trained men to the Forest Survey. Several young officers, to whom I made proposals to that effect, raised objections: "We have learnt surveying and do not require further practice in that work. It is more useful for us to stick to Forest work proper." Bailey, while at home on furlough, had visited Nancy, and Bagneris, one of the Professors, had recommended him to get Hill for the Forest Survey. When the proposal was made to Hill he agreed at once, and his joining the Forest Survey has proved most useful to himself and to the public service. Colonel Bailey writes: "During the time Hill was under me, I formed a high opinion of his ability and devotion to his duties; he quickly picked up the work, and in due course rendered valuable assistance in the development of the Survey Branch."

In 1876 Hill was transferred to Burma, where he was first employed in Tharawaddi and Prome on demarcation work and afterwards held charge of the Toungoo Division. At this transfer he did not grumble for he realized that service in Burma was a necessary preparation for advancement to higher and more responsible positions. In 1866, when I had the good fortune of selecting two distinguished young German Foresters for the Indian Forest Service, Dr. Schlich and Mr. Ribbentrop, my idea was that, if all went well, the former would eventually succeed me; accordingly I arranged that he should be posted to Burma and afterwards successively to other Provinces. Again, in 1874, when we were together in Jaunsar, I informed Mr. Ribbentrop that his time had come to go to Burma.

My reason for this action was, that the forests of lower Burma had since 1856 been worked on a well-considered plan and had ever since that time yielded a steadily increasing annual crop of teak timber and of revenue, while in other Provinces similar results had been attained at a much later period. Now, since the annexation of upper Burma, the net annual revenue produced by the Burma forests equals the net forest revenue of all other Provinces taken together. It stands to reason that service in Burma must be regarded as a necessary preparation for employment in the highest appointments.

Hill soon distinguished himself in Burma. From 1881 to 1884 he was acting as Conservator, first in Tenasserim and afterwards in Pegu. Subsequently, in 1885 and 1886, he was

Conservator of Forests in the Punjab, until, after the annexation of Upper Burma, he was sent back as Conservator of Forests and *ex-officio* Secretary to the Chief Commisioner in the Forest Department for Upper Burma. In August 1889, he was appointed to act as Inspector-General of Forests. The remainder of his career is well-known to the readers of the *Indian Forester*.

He was on furlough at home from March 1891 to March 1893, and on that occasion (summer of 1891) I had the privilege of his company on a three months' tour with the Cooper's Hill Forest students. This was the fourth tour I had undertaken, and my experience had led me to the conclusion that these three months' tours were to a great extent a waste of time and money. Hill at once understood the position. He saw that, though the students had had the inestimable privilege of Dr. Schlich's excellent teaching, the majority of them did not realize the importance of their own profession and did not fully understand what they saw on these tours. It was due mainly to his influence that the new system, which I had advocated, of sending the Cooper's Hill Forest students to Germany for actual service under Prussian Forest officers, was sanctioned, and this period of preparatory service has now fortunately been extended to nine months. Under this system, which was established with Dr. Schlich's full concurrence, the students now derive the full benefit of his excellent teaching, and this probably is now acknowledged by all those who have had the privilege of studying at Cooper's Hill.

Hill fully realized the necessity of making Forestry indigenous in India and the drawback of its remaining an exotic plant. He appreciated the advantage of inducing young Native gentlemen of the more influential classes to enter the Forest School and the Forest Service. He strongly supported the proposal to class Forest Rangers in the Provincial and not in the Subordinate Service. In this respect he did not succeed, but in course of time Forest Rangers will doubtless be classed in the Provincial Service.

Hill did not claim to be a scientific man either in Botany or in Zoology. He was familiar with the trees and animals of the forest, and he approached the manifold questions, which the treatment and management of forests present in India, from a scientific point of view. We all know that he was truly great as a sportsman, and this was an important advantage to him in his work.

A Forester, more than almost anybody else, must use his eyes and must be able on the spot to draw conclusions from what he has observed, and the training of a sportsman is an excellent help in his work. It makes life in the forests delightful to him, it induces him not only to *visit* the forests, but to *live* in them. He becomes much easier familiar with the development of the growing stock

and its requirements, than a man who is not a sportsman. It gives me great pleasure to call to my mind the great achievements in Indian Forestry of Colonel Pearson, Colonel Doveton, Colonel F. Bailey and the late Colonel Peyton. These eminent men had not had the privilege of a regular training in their profession, but their love of sport made the forest their home, and this is the first condition of success in our business.

The readers of this paper will not misunderstand me. I have often heard people in India, as well as in England. say that a keen sportsman must necessarily be a good forester. This is about as absurd as the idea which, until a short time ago, was current in England, and which to this day is held by many English botanists, that a good botanist must necessarily be a good forester. Both love of sport and devotion to Botany or Entomology are most useful helps, but they are not Forestry. The forester's business is to solve the problems of sylviculture and of forest management in a practical manner, and Hill realized this to the fullest extent.

Hill loved his profession: success in sylviculture, in forest management and in adminstration, was the aim of his ambition. He was strong and determined in endeavouring to carry what he considered necessary for the welfare of future generations in India. At the same time he had great tact and he readily gained the confidence of those who were associated with him in public affairs. I am proud of having had the privilege of his confidence and his friendship.

Recollections of the early days of the Indian Forest Department, 1858–1864.

By Colonel G. F. Pearson, I.F.S., Rtd.

In the year 1858, when the embers of the Mutiny were still smouldering in the country, I was in command of a regiment of Military Police at Seoni in the Central Provinces. The *corps* consisted of a squadron of Cavalry and four companies of Native Infantry, in all about six hundred men with three English officers. It was in September of that year that Tantia Topee made his celebrated raid into the Deccan During the raid he halted for three days with three thousand Cavalry at a place on the Pench river, not sixteen miles from my station. We fortified the public offices as best we could with entrenchments and sandbags, but whether his horses and men required rest, or whether he considered us too insignificant to claim his attention, he did not attack us, but retreated across the Nerbudda on learning that a British regiment and at least two batteries of Artillery were stationed at Nagpore, which was without doubt his real objective. He was not long after captured in Rajputana and his followers broken up and

dispersed. While he was near us we had an anxious time; I can vouch for it that there was little sleep for any one in Seoni until he retired across the Nerbudda.

My principal duty while in command of this force was to patrol the country, rout out any mutineers and disaffected natives who might be skulking in the hills or forests, and it was while employed in this way that my attention was first directed to forest conservancy.

As soon as the Mutiny was suppressed the railways were taken in hand and the timber merchants and sleeper contractors raided the forests for timber, felling trees wherever they liked, generally finding they could not remove them after they were down. It was only necessary for a contractor, whether European or native, to obtain a parwana or order from the civil authorities to cut timber for him to set to work, and as every Gond carried an axe it was not long before the forests were strewn with fallen logs, no attempt being made to collect or store them. In fact in many cases it was impossible to do so, with the result that the greater part of the timber was either totally or partially destroyed when the forest fires set in. I continually brought this to notice in my reports, and my having done so, no doubt paved the way to the formation of a department whose duty would be the preservation of the forests from ruin. It may be of interest to mention that the granting of these parwanas was not without its after-use, as when the rights of Government to the forests and timber in them were questioned, they helped to prove a claim. The use of the term 'Conservator' was also deliberately adopted at this time by Government, as indicating more strictly the first duty of the Forest Department. Then, as now, there was a disposition in some quarters to insist on its being a revenue-producing department, an idea which, if carried out, would necessarily end in forest destruction.

In the spring of 1859, under instructions from Mr. A. Cox, Officiating Commissioner of Jubbulpore, I made a thorough inspection of the forests of the Mundla plateau and of those along the Meykeel range as far as Bundhara. Starting from Mundla in March, I marched through the Khormeyr country, which forms the upper basin of Nerbudda, to Amar Kantak, from near which place that river takes its rise. To this point the Satpura and Meykeel ranges converge, forming the two great plateaux of Amar Kantak and Goura Dadur at an elevation of 3,500 feet above sea level, and I have a vivid recollection even at this distance of time of the grand view obtained from them, standing out as they do like great headlands into the plains of Chattisghar and Paindra, fully 2,000 feet below them. I remember, too, on the Choura Dadur falling in with a splendid herd of *bara singah* or Indian red deer, in the open, and by careful stalking I managed to secure

the stag, whose horns—with those of a large buffalo I shot near Raigur Bitchia—are now on the walls of the hall in my brother's house in North Wales.

From Amar Kantak I turned back to the S. W., following the ranges for nearly 200 miles, visiting every hilltop and dadur, exploring the forests, noting their contents and getting as far as possible into touch with the Bygars and Gonds inhabiting them, so as to endeavour to learn something of their habits and customs. I need not speak in detail of the forests I visited as they are now well known, but I may mention that while the mature teak in the Bormeyer and Khormeyr valleys was nearly all destroyed and burnt in the same way as in Seoni, the sal forests on the upper plateaux and on the Kunjar river were practically untouched. There was splendid shooting to be got in this country. I succeeded in securing several good heads from amongst the herds of red deer and buffalo which roamed about amongst the glades between the forests almost unmolested by man, and which, until I came, had probably never heard the crack of a rifle. While I was making my way south along the Meykeel hills I got news of a man-eating tiger which infested a pass over the hill range dividing the upper waters of the Halon river from those of the Bunjar river. I determined to try and shoot him. Just before reaching the place I met a party of Gonds who had crossed the pass at a village called, I think, Bheenlat in the upper Bunjar valley. When crossing the pass they had with them a poor woman carrying her two-year old son in a cloth on her back, who probably being tired had fallen behind the rest of the party, and had become a prey to the tiger who, as usual, was on the lookout for stragglers. The Gonds at first ran away, but returned later armed with tom-toms and matchlocks to try and recover the bodies. On arriving at the place where the woman had been seized they found the boy sitting almost unharmed within a dozen paces of the spot where the tiger had dragged and was eating his mother. I could find no father to claim the boy so I pensioned him off on Rs. 2 a month to an old couple who brought him up until he was able to earn his own living and when I last heard of him he had grown into a fine strong boy well able to take care of himself. I had several tries at finding this tiger but was always unsuccessful as he had probably been frightened away for the moment by the return of the Gonds. I believe he was afterwards shot by Mr. Jacob.

It was about this time, too, that the famous Doomah panther played havoc with men, women and children in the northern part of the Seoni district. This beast was credited with no less than ninety-three human kills, reported at my police station in Doomah, in one year. Certain it is that he killed three people in one night in the immediate vicinity of the village, one of them being the mother of one of my sowars whom he dragged out of a

hut in the police lines. Both Captain Thompson and myself had many tries for her, but always failed to kill her, though Thompson missed her once. She was eventually killed by a native shikaree, to whom the reward of Rs. 500 was paid, after no more kills had occurred for six months. The panther's range was from ten to fifteen miles round Doomah and he seemed almost ubiquitous, killing in one place one night and in another ten miles off the next. There were many stories afloat amongst the natives about this panther, the favourite one being that he had been a Bygah priest, who by means of taking a powder had the power of turning himself into any animal he liked, and by taking another powder of returning to human shape. While travelling through the jungle with his wife, finding their road blocked by a panther, the priest took one of the powders to turn himself into a panther and drive off the intruder, at the same time giving his wife instructions to give him the other powder when he returned from having done so; but his wife, on seeing him in the form of a panther, was so frightened that she dropped the powder and ran away, causing him to remain as he was. The priest's rage at this was so great, so the native story ran, that out of spite he killed every man, woman or child he could find. But against this theory was the fact that the true culprit was a female and the question was asked: "Had the powders the effect of changing the sex as well as the form?"

In August 1860 I was appointed Conservator of Forests in the Saugor and Nerbudda territories and had two assistants allowed me. I selected Lieutenant Forsyth of the 26th Punjabis and Lieutenant Douglas of my own regiment, the 33rd Madras Native Infantry, for these posts. They both turned out excellent men for the work, Forsyth being one of the ablest men I ever had under me; indeed, so able a man was he that three or four years after he was singled out by Sir Richard Temple for civil employ and appointed Deputy Commissioner and Settlement Officer of Nimar. His settlement report of that district was, I believe, considered second only in importance and ability to that of Sir Charles Elliott for Betul and Hoshangabad. Forsyth's early death, brought on largely no doubt by exposure and overwork, can never be too deeply regretted either by his friends or by the public service.

Our first work was to collect in depôts at Jubbulpore and Mundla as many of the half-burnt logs, which were strewn over the forest, as was possible. We soon had many thousands of logs collected and the proceeds of the sale of these furnished the funds of our first modest little budget for 1861-62.

In 1861 the Central Provinces were constituted as a Chief Commissionership under Sir R. Temple, and the Southern Province was added to my charge, and in the following year the Berars with the valuable Melghat forests were also placed under me. The whole of these years were spent in exploration, and each

year I marched over two thousand miles, besides doing the forest work. I twice visited Puchmuree during this period and negotiated with the Takoor for the lease of the plateau to the British Government. In all this work I was ably seconded by Forsyth and Douglas; Forsyth building the forest bungalow on the Pachmuree; Douglas examining and reporting on the teak and sal forests in Mundla while I was working in the Boree and Betul forests. Forsyth's share of the work is admirably told in his well-known book "The Highlands of Central India."

At that time the jungles of Betul and Hoshangabad were literally swarming with tigers, and I soon got in touch with them while doing my work. I once came across four full-grown tigers lying in the shade of a rock by a pool on the Machna river, six or eight miles below Sharpur. I was liberally supplied with Commissariat elephants and besides had my own excellent shooting elephant, Fulty Ranee, so that I never had any difficulty in following tigers. Perhaps one or two stories of man-eating tigers I shot may not be without interest.

The worst man-eater in the district was a tigress infesting the ghat on the road from Sharpur to Betul. She had killed over sixty people in eighteen months and had twice taken the dâk runner, so that it was difficult to find any one to carry the mails. As she killed cattle as well as men, which is not usually the case after a tiger has taken to man-eating, I determined to try and find her near one of her kills as soon after it had taken place as possible. I soon got news of her having killed a buffalo and at once set off on Fulty Ranee accompanied only by one or two natives who knew where the kill was, as she was reported to be very bold and not at all afraid of the approach of man. No sooner had I got there than I saw her move out of a nullah, into which she had dragged her kill, and across some open ground perhaps a quarter of a mile wide, to a small isolated hill covered with grass and low scrub, sitting down near the top of it and watching me. Not wishing to risk the lives of any of the men by trying to drive her, and also to see what she would do as the country behind her was rather open, I determined to see how near she would let me approach her. She allowed me to come to the foot of the hill without moving, so I told my mahout to advance very slowly up the hill. I had my smooth bore gun loaded with a single bullet in the right barrel and two bullets in the left, a practice I always adopted when after tiger. We continued to mount the hill step by step, expecting the tigress to charge at every moment, but still she did not move but crouched on the ground facing me, and therefore offering a very bad shot, especially as she was above me. When within twenty yards of her I judged it better not to delay any longer, lest she should take the initiative and charge, as a couple of bounds would have brought her on top of us; so aiming between the eyes I fired the right barrel at her. I hit

her fair and she came rolling down the hill like a shot rabbit, passing within a few feet of the elephant, and roaring fearfully as she passed. I fired the left barrel, with the two bullets in it, hitting her under the shoulder and killing her dead. There was great rejoicing in Sharpur that night.

Had I not seen it myself I would never have believed that a tiger would act as this one did, never moving when attacked. My mahout and elephant both behaved with the greatest coolness and pluck under very trying circumstances, never faltering or showing sign of fear at any time. I missed the tigress' male companion two days afterwards in a miserable manner, but as no more men were killed I felt more or less consoled.

Soon after shooting this tiger, and while still in the neighbourhood of Sharpur, I received a message from Sir Charles Elliott, the Settlement Officer, who was then encamped at Rajaborari on the extreme western border of Betul, telling me that a tiger near there had killed ten people in as many days and asking me to try and shoot it. It was then late in May and very hot, and having from twenty to thirty miles to go I determined to march at night, making a halt to feed and rest my elephants in the early morning. I arrived at Rajaborari about three o'clock in the afternoon and determined to try and find the tiger at once, before he began moving about in the cool of the evening. I learned that he had killed a boy on the previous evening and was probably lying up in a dry nullah not far off, so taking the village policeman, who had been with the boy when he was killed and knew the place, I proceeded to the spot I found the tiger's lair to be an insignificant nullah covered along the bottom with 'jhow,' and with several shallow pools of water in it. I had not gone twenty yards up the nullah when the tiger slowly raised himself into a sitting position just in front of me, offering me a full chest shot. I fired both barrels at him and he fell dead by the side of his victim, whom he had devoured up to the armpits, the head and shoulders alone remaining—a truly ghastly spectacle to look at. He was, I think, the longest tiger I ever shot, being considerably over 10 feet, though I do not recollect his exact measurement, but he was miserably thin and was suffering from a festering and jagged wound reaching from the shoulder to nearly the tail, caused evidently by an iron bullet from some native shikari's matchlock. I believe that this tiger had taken to man-killing because he was unable to kill animals on account of his wound and was slowly starving to death. I received a considerable reward (Rs. 500 or more) for killing these two tigers, which I spent in founding a school for Gond villagers in Upper Machna, where the schoolmaster had not yet made his appearance. I daresay by this time they are so educated that I should not recognise them as the same people as I knew. I wonder if there are now any Gond rangers at the Dehra Forest School?

In 1863 Doctor (now Sir) Dietrich Brandis was appointed the first Inspector-General of Forests in the early months of that year. I was summoned to meet him at Nagpur. We marched together to Allicutta on the Pench river, and from there I conducted him through the teak and mixed forests at the foot of the Korai Ghat range as far as the Wyngunga, and then for a short tour in Mundla. I remember that he was greatly pleased at my being able to go through the forests without a guide, but I should not have been able to cover a quarter of the ground that since my appointment to the department I had explored, nor should I have been able to acquire the knowledge of the forests and their contents, as well as of the tribes that inhabit them, which I possessed had I not early learned to do so. It is a habit which every Forest Officer should cultivate.

It was in conversation between Sir Dietrich and myself during these marches that the main points of our forest policy were discussed and laid down in a preliminary manner, and it may be said that ever since then they have governed the working of the Forest Department. These points were :—

I.—Demarcation of reserves.

II.—The protection of forests from fire.

III.--Sources from which a forest revenue might be raised.

It was then decided to select two blocks of forests in which practical experiments in protection from fire should be carried out. After mature consideration I selected for this, and Sir Dietrich fully concurred with me, one block in the Boree forest at the foot of the Puchmuree hills, and the other block in the Jugmundel forest on the Khormeyr plateau of the Mundla hills. Both were forests capable of isolation by the natural features of the country and were in other ways well adapted for the experiment. For carrying out the work in the former I obtained the services of Lieutenant Doveton, 1st M. N. I., and it is to his unremitting zeal and watchfulness, as well as to the tact he showed in dealing with natives, that this work was carried to such a successful conclusion. It is impossible to overestimate the importance of this success as most foresters and every civil officer in the country scouted the idea of forest protection from fire and everything connected with it, and had the attempt been a failure, any progress in fire-protection elsewhere would have been rendered immeasurably more difficult. As it is everyone connected with Indian forests knows what a large part fire-protection now plays in forest conservancy, and it is to Colonel Doveton that this is largely due. I am glad to think that he succeeded me as Conservator in the Central Provinces on my transfer to the N.-W. Provinces in 1868. During the twenty years he held that appointment, he built up the efficient forest department existing there now.

The Jugmundel fire-protection reserve was placed in charge of Lieutenant Douglas, but it was not at first attended with the same success as in the Boree reserve. This was in no way due to any want of attention or care on the part of that officer, but solely to the hostility of the Ahirs in charge of cattle brought up from the lowlands to graze in the Mundla uplands, who wanted to burn grass for their own purposes.

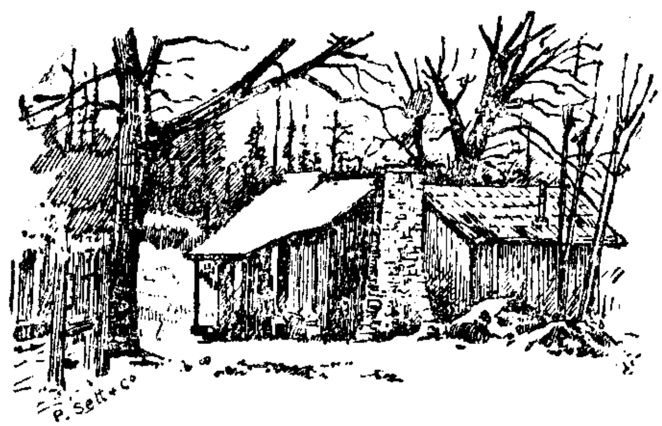
From Mundla Sir Dietrich and myself visited the Beejarago-ghur sal forests on the Rewah frontier, where Lieutentant Douglas was arranging for a supply of sleepers for the railway in course of construction from Allahabad to Jubbulpur. I recollect that on our arrival in Douglas' camp we found waiting for us an excellent breakfast, carefully laid out by his Madras servant on a white table cloth with real bread and butter—a luxury we had not had for some time. Sir Dietrich was much pleased at this and remarked to me that Douglas would made a good forest officer 'for he pays attention to details.'

The Inspector-General and I parted company here. I returned to spend the hot weather in the Boree forest to start the fire-protection schemes. The next year was chiefly spent in the Berar and Melghat forests, and in June I went home, not seriously ill, but in need of a rest after seven consecutive hot weathers spent in the plains, and all the early portion of the rains spent *in camp or in huts, with constant work and little rest.*

With all the means of locomotion that now exists forest officers of the present day can hardly know how rough the life was in those early days of forest work. Still, there were many compensations. We had less office work to do and a liberal supply of Government elephants at our disposal, and a good supply of tigers and other game in the forests whenever opportunity offered to go after them, and it may be of some comfort, even now, to some fever-stricken forest officer to know that, although in my 77th year, and over thirty years after I have left India, and in spite of my being saturated with fever when in India, I am thankful to say I am quite as active as any of my neighbours of the same age, who have never left England.

Notes from an American Forest Reserve.

By Charles Howard Shinn,
U. S., Head Forest Ranger.



The American forest reserve system is unlike any other known to me, and though now only in its beginnings, has large possibilities of future usefulness to the nation. The method followed has been to withdraw from sale all Government land within certain desired limits, and after careful examination of these lands has been made, the President of the United States sets them apart as Forest Reserves. Following this plan, fifty-six such reserves now exist, all under the care of the Commissioner of the General Land Office, who is the chief of a bureau in the Department of the Interior, one of the eight great executive departments of our Government.

On June 30th, 1902, when the last annual reports were issued, these reserves numbered fifty-four, and embraced a total area of considerably over sixty million acres. If a number of new reserves now proposed are created, the area will be carried up towards eighty-five million acres. The withdrawals preliminary to the establishment of new reserves, and additions to those existing, numbered nineteen in 1902, and two more withdrawals had been made for the creation of state forest reserves, making a total of twenty-one possible additions.

Besides these forest reserves there are a number of National Parks in the charge of the War Department and patrolled by soldiers. Then, too, the Bureau of Forestry of the Department of Agriculture, which has charge of the scientific and technical foresty work of the Government, has certain small but important reserves where experimental work is constantly being carried on. The Bureau also advises and plans for many lumbermen, and other owners of vast tracts of forest land.

It may be that all the forest responsibilities now scattered through three departments of the federal Government will finally be drawn together in some shape so as to be subject to one authority. We may come at last to have a Secretary of Forestry and Water Supplies sitting in the President's cabinet, but that time now seems remote.

The reserves are widely scattered, from Alaska to New Mexico; but most of them are necessarily in the west and on the Pacific Coast, though a great struggle is now going on to create a magnificent reserve in the heart of the Appalachian Range—in the famous mountains of Virginia, the Carolinas, Tennessee and other old States. California now has eight reserves, and the land for several more is withdrawn from sale, so that it is likely that a long chain of such forests will some day extend along the entire length of the Sierra Nevada mountains.

The largest California Reserve, named the Sierra, is that where I am stationed, and covers 4,096,000 acres; four others in America are somewhat larger. It is a great land of foothills and mountains, rising from an elevation of about 2,500 feet on the western slope of the Sierra Nevada, to the eternal snows of such peaks as Lyell and Whitney nearly 15,000 feet high and extending far down the eastern slopes. It contains enormous bodies of very fine timber, much of which is however inaccessible until roads have been cut or lumber flumes have been built from the valley. Its problems of management, exploitation and development into almost continuous forests are peculiarly those of a very wild mountain region.

The leading timber tree is the Yellow Pine of the Pacific Coast (*Pinus ponderosa*), which, as one ascends towards the snow, changes to the higher mountain form, *P. jeffreyi*, often called but a variety. From the forester's standpoint the Jeffrey Pine differs little from the smaller-coned, more golden-barked and larger *P. ponderosa*, but it is even hardier, and is the great timber tree of the Carson mountains in Nevada, of the Lake Tahoe basin, and of many other districts.

The superb Sugar Pine, *P. lambertiana*, is beyond question one of the lordliest and most valuable of California trees, but it does not occur in such forests as does the Yellow Pine, nor is it capable of such easy and rapid reproduction. The same is true of the small-coned or Little Sugar Pine (*P. monticola*), which belongs to the higher ridges, usually above 6,000 feet, and occupies about the same relation to the large Sugar Pine that P. *jeffreyi* does to *P. ponderosa*.

The two great Firs of the Sierra Reserve are the Red (*Abies magnifica*) and the White (*A. concolor*). Both form great bodies of timber and will in time have much commercial value, but now can seldom be profitably cut. The same is true

of the abundant Western Tamarack (*Pinus murrayana*) that grows in moist meadows at great heights. In Nevada this pine, also the Mountain Hemlock (*Tsuga mertensiana*), and even the fir, are cut for firewood, and thousands of cords are annually flumed down to the valleys. But California, with its great supplies of firewood, petroleum, etc., is not yet ready to utilize these coarser woods for any purpose, excepting the fir for paper pulp, and to some extent for shingles.

The deciduous forest here is a beautiful one, including several fine species of Oaks, besides the Western Ash, the giant Dogwood (*Cornus Nuttalli*) and lesser trees. The oaks are as yet unused except for firewood, but experiments made upon their timber show that they possess remarkable beauty and grain, so that this forest-asset will in time become very valuable.

All of the reserves contain private holdings, as men had settled there and had "taken up" land under the American laws before the reserves were created. Some of these holdings were used for pasture, some for farms. The policy of the Government has been gradually to exchange lands elsewhere for these holdings. The rules and regulations of the reserves are of course enforced throughout the entire area. In fact, the reserves contain miners, prospectors, cattle men, hunters, farmers, lumbermen cutting their own timber, and in summer many campers and pleasure-seekers. The officers in charge of a reserve must deal with many subjects, and must meet many people. Their professional duties of surveying the timber, clearing brush, making firebreaks, thinning young forest, burning waste and trash, gathering seed and planting it, keeping records and maps, and all the daily details of forest life, are mingled with care for the needs of many persons. Free firewood and free timber for the actual use of the applicant, but not to sell, free pasturage for the number of horses and cattle that the range is estimated safely to carry (but usually not for sheep, goats or hogs), come within his daily duties, and many similar items could be mentioned if space permitted.

The sale of "down or dead" timber is going on in various reserves, and the sale of ripe but growing timber is beginning. Preliminary surveys and actual working-plans are being made, and the United States Geological Survey has published stately volumes, with abundant maps, upon the topography, soil and tree-growth of a large number of these reserves. This preliminary work is still going on, and will cover the entire system.

At the present time, the lowest forest worker is the Ranger of the third class, who receives $60·00 a month and furnishes his own camp outfit, including saddle and pack horses. Above him are two grades of Forest Rangers, receiving respectively $75 and $90. Over these are the Head Forest Rangers, who are

assigned to different reserves and whose salaries vary according to their duties and responsibilities. Some of the reserves have another officer known as a Supervisor; in some cases the Head Rangers take the place of the Supervisors. Each of the Forest Superintendents have charge of a number of reserves. There are two such in California, one north of the Tehachipi, one south. The Forestry Division of the Office of the U. S. Land Commissioner at Washington is the head of the whole system.

The total force of the forest rangers of the three lower classes is about 425 in the summer, when the danger from fire and trespassers is greatest, but it is considerably reduced in the winter. This force is of course inadequate to do very much besides making trails, and patrolling and preserving the forests, though by careful organization some thing is being done with forest surveys, fire-breaks, brush-clearing, the thinning of young pine thickets, etc. The rangers are, as a rule, hardy and intelligent young Americans, full of enthusiasm for the work.

As the force increases. and as timber sales and paid-for cattle-range leases on a large scale begin, the reserves will become self-supporting.

This brief paper is only a glimpse of the beginnings of a great forest system. The work presses, the labourers are few, and there is no time for writing long articles. California already has nearly nine million acres of forest reserve, all in the high mountains. A forest officer must make a number of headquarters at various elevations for summer and winter; wagon roads are few and the pack-mule is his main dependence for supplies; a hundred miles on horseback "across country" down into canôns a thousand or more feet in depth, or over snow-covered ridges above fair vales of the grape and olive, is but a little journey in this land of the Sierra Nevada, this mighty rock-wall of the western third of North America. Still there is fellowship here, in the snows of March, with foresters all over the world; still the *Indian Forester* brings to this mountain cabin the fascinating story of your lowlands and uplands and white Himalayan ridges; of your great and long-disciplined forest army welded together for the service.

Forestry in America.

By H. J.

There was published in the *Pioneer** a short time back a report of a speech made by the President of the American Republic to the Society of American Foresters at Washington—(Why is there no Imperial Society of British Foresters ?)

* *Vide* p. 301, July number of this Magazine.—Hon. Ed.

The speech shows the great interest taken in the United State in forest matters, and the importance attached to the preservation of forests by the administration of the country.

After stating that a conservative forest policy is an essential part of the government of the country, the President defines the object of forest conservation to be the making of prosperous homes. Like Sunlight Soap, it "makes homes happy." He then insists that the success of home-makers depends in the long run upon the wisdom with which the nation takes care of its forests.

Forestry Mr. Roosevelt happily defines as "the preservation of forests by wise use," and then proceeds to mention some of the aspects in which the utility of forests is most conspicuous. Forest protection alone, he says, can maintain the supply of water in the streams necessary for irrigation, and can prevent destructive floods and erosion of the ground. Then the relation between the forest and the mining industry is a very close one; mines cannot be developed without timber, usually not without timber close at hand, and in many regions of the West, ore is more abundant than wood.

The forest resources of the United States have been, the President said, already seriously depleted, and they can be renewed and maintained only by the co-operation of foresters and the timber-traders. He ended by counselling the foresters to seek to realize their ideas in practical ways, and said that the forester's profession is one of the greatest importance, of the highest usefulness to the State, and stands as hgih as that of law or medicine.

The forester should acquire not only a thorough knowledge, a knowledge that goes deep, but also a wide outlook over all the questions which have to be touched. This profession concerns the State in many ways—politically, socially, industrially, and commercially—and requires a wide acquaintance with the general life of the nation, and a view-point both broad and high.

It is no new thing for us to admire the thoroughness of our trans-atlantic cousins, and their businesslike practical methods, and there seem to be clear indications now that the Americans, after having learnt everything that the Old World has to teach them in the matter of forestry, are coming to lead the way among the nations of the earth in this profession which they esteem so highly.

A most interesting and valuable book, called Economics of Forestry, has been written by Dr. Fernow, Director of New York State College of Forestry, and late Chief of the Division of Forestry, United States Department of Agriculture.*

* This book was published last December by Thos. Y. Crowell & Co., New York—$1·50.

This most excellent and comprehensive work, without being a manual of forestry, is intended as a reference book to lay and professional students of forestry and political economy.

A brief review of its contents may be of interest:—

Chapter	I.	Introductory.—Relation of the State to Natural Resources.
"	II.	The forest as a resource.
"	III.	The forest as a condition.
"	IV.	Forest, and forestry, defined.
"	V.	Factors of forest production, and business aspects.
"	VI.	Natural history of the forest.
"	VII.	Methods of forest crop production. Sylviculture.
"	VIII.	Methods of business conduct. Forest Economy.
"	IX.	Principles and methods of forest policy.
"	X.	Forest policies of foreign nations.
"	XI.	Forest conditions of the United States.
"	XII.	The forestry movement in the United States.

Chapter I explains how the natural resources of the earth, so long as their exploitation is left unrestricted in private hands, have always been squandered by man with a wanton disregard of the future; for private enterprise knows only the immediate future, and has but one aim to obtain from the forests the greatest possible personal and present gain. The necessity for the limitation of private rights finds expression in the old Roman law—*Utere tuo ne alterum noceas*, in which *alterum* may be taken to include the citizen of the future as well as of the present time.

The permanency of the State makes it the guardian not only of present communal interests as against individual interests, but also of future interests as against those of the future.

There is no doubt that the importance of the economy of resources has not hitherto been sufficiently recognized, although it is admitted that man is constantly modifying the earth, and making it more and more uninhabitable: he goes over the rich portions, and leaves behind him a desert.

Increase of population, and increased requirements of civilization, necessitate an increased intensity in the management of our resources; although, as individuals, the knowledge that the coal fields cannot last for many centuries more, does not induce any one to deny himself a single scuttleful of coal, until this knowledge is reflected in increased price. Resources may be classified as—

(1) Inexhaustible, such as land, water, air, and the forces of nature.

(2) Exhaustible, and non-restorable, such as coal, silver and gold mines, and oil-wells.

(3) Restorable, but liable to deterioration under private activity. This class includes the forest, and its game, the water power of its streams, which depend on the condition of the forest; the fisheries, and local climatic conditions. Both in Europe, Asia, and America, vast regions have been transformed into lifeless deserts by the destruction of forest cover.

The 4th class of resources are restorable, but yielding *increased returns under increased activity; these resources are* mostly the product of human labour, industry and ingenuity, such as wealth, the means of public education, and other conditions of civilization.

Again, resources may be distinguished as either objects of industrial enterprise, yielding the necessaries or conveniences *of life, or else as serving, perhaps indirectly, for the comforts of* society, industry and progress of civilization, while offering little or no incentive for private action.

Thus the forest, so long as it merely yields timber and useful materials for the arts, is an object of private industry; but when from its position on a watershed the forest becomes an important factor in the water conditions of the plain, it may still be an object of private industry, yielding gain and wealth, but its indirect significance for society at large exceeds the private interest.

The policy of Government control over waterways, roads, and lands falling under the operation of "eminent domain," the right of the State to restrict private owners in the use of their property *for the sake of the common weal, is well established* everywhere, and should be extended with even more reason to all exhaustible, non-restorable, resources.

The three great resources upon which mankind is most dependent, are the soil as food producer, the water, and the climatic conditions.

The fertility of the soil can *generally* be *said* to be restorable, and may therefore be left to private enterprise so long as the soil is utilized, but not otherwise. A rational management of the water capital of the world in connection with the agricultural use of the soil is an economic problem of the very highest importance, as the necessity for increased food production calls for intensive methods, and without forest management no satisfactory water management is *possible* for any *length of time*, no *stable* basis for continued productive agriculture, industries, or commerce.

To the individual, it is the timber, the accumulated growth of centuries, which is of interest in the forest; whereas the function of the forest as a soil cover by preventing erosion of the ground, by regulating the water flow, by its relation to local climatic conditions, pre-eminently renders it an object for the exercise of the providential functions of the State, to counteract the destructive tendencies of private enterprise.

CHAPTER II.—THE FOREST AS A RESOURCE.

No material, outside of food products, is so universally used, and so indispensable in human economy, as wood: and it is estimated that over 99 % of all wood is used to supply real wants, and less than 1 % to supply luxuries, such as fancy articles, carvings, and other decorations.

These figures refer of course to the net wood product after conversion, as the unavoidable wastage, which is in most cases a total loss, amounts to about 50 %.

This waste per cent. diminishes as the size of the timber increases, and in the case of a log of 3 ft. diameter, for example, will amount to about one-half of the waste per cent. with logs of one foot diameter.

The innumerable uses of wood required in every sphere of human civilization are briefly referred to, and are shown to be constantly increasing, as is exemplified in the modern manufacture of wood pulp for making paper, etc.

It is estimated that in the United States, each family uses on an average about 2,000 c. ft., or about 80,000 pounds, of dry wood per annum, the annual product of at least 50 acres of forest.

The reasons for this universal and varied application of wood are briefly gone into, and the technical and physical qualities of wood as compared with iron and other substances are described. In the combination of strength, stiffness, elasticity, and lightness, wood excels all other known materials, and it is further recommended by its ease in working, and above all things, by its cheapness.

In addition to timber and fuel, and wood pulp (from which both collars and car-wheels are made!), the forest furnishes other materials of no mean value, such as tan bark, turpentine, varnishes, sugar, alcohol and fruit, and other minor produce.

From the standpoint of wealth production, the relative position which the forest resources, and their working, take in the household of a nation, can best be learned from a comparison with other sources of wealth and their production, taking into consideration the different revenues, the capital invested, the value of the product, the number of people employed and the wages paid. In the States, it is estimated that the net money

value derived annually from the forests is equal to a two per cent. dividend on the entire wealth of the nation; and this unfortunately is largely paid from capital stock, whose deficiency future generations will have to make good.

An estimate of the potential forest area over the earth's surface, shows that about 60 per cent. of the total land area is capable of forest growth, and that this percentage, or 18 billion acres, has to be divided between agriculture and the forests.

An estimate of the world's requirements of wood material is given, showing that in North America the wood requirement per head is 500 feet board measure. (Board measure means converted timber; 100 c. ft. of timber unconverted being figured as producing 600 feet board measure sawed material.)

In Europe, and in all other countries, the corresponding wood requirements in board measure, are respectively 60 and 4 feet. The average for the world's population of 1,600,000,000 inhabitants is about 38 c ft. of wood per head, of which between 6 and 7 c. ft. are timber, equivalent to 40 feet board measure.

A table is given, showing the different quantities of timber furnished by different countries. Out of the estimated total of 66,500 million feet board measure, the United States produces 37,000, more than half; Russia comes next with 12,000; then Austria, 3,500; Germany, 3,000; Canada, 3,000; Norway and Sweden, 2,000; China and Japan, 2,000; France, 1,500; South America, 1,000; and India, 500.

In the United States, the use of wood per head is about 350 c. ft., and exceeds that of all other civilized nations; about one quarter of this wood, or 85 c. ft., being timber.

England (Great Britain ?), importing all her requirements, wants only 13 c. ft. of timber, and Germany, who imports 25 % of her requirements, needs 43 c. ft. of wood per head, of which 15 c. ft. is timber.

In the natural uncared-for forest, the production is always much smaller, and the produce of an inferior quality, than in a well-managed forest, and the wastage in conversion is very considerably greater.

The natural forest resource, as we find it, consists of an accumulated wood capital lying idle, and awaiting the hand of a rational manager to do its duty as a producer of a continuous highest revenue.

Rational management will not consist in simply extracting the more valuable portions of the growth, as is done in the crude exploitations of newly developed countries, but rather in preparing first for the desired reproduction by cutting out the useless kinds and the brush, and then felling only those mature trees of the

better kinds which will surely be replaced by young growth. Thus, by wisely utilizing the resource, the produce can be harvested and at the same time a new and improved crop is secured.

The extent to which the yield of the forest may be increased by good management can be well judged from the results of German forest administration. The more extensively managed Prussian State forests, with an area of 6¾ million acres, lately produced, as an average for a series of years, 42 cubic feet of timber (over 3 inches diameter) per acre per annum; while the most intensively managed State forests of Saxony (probably also with better soil and climate) produced 90 cubic feet of wood per acre per annum, of which 68 cubic feet was timber.

A financial calculation shows that this States property has not only paid 3% continuously in revenue, but has risen in value 24 per cent. by mere accumulation of material.

Meanwhile private forests in the German Empire seldom produce more than 30 cubic feet of wood per acre per annum, of which about 12 cubic feet is timber.

In considering this revenue of 3 per cent, it must be remembered that the forest areas are mainly confined to non-agricultural lands.

In conclusion, *per aspera ad astra* (which we may take as the American equivalent of *meliore speramus*) is given as the history of the settling of the backwoods of the United States which the pioneer woodsman has accomplished.

Chapter III.—The Forest as a condition.

It has been already stated that 60 per cent. of the entire land surface of the earth may be classed as actual or potential woodland, and, except under unfavourable conditions of soil or climate, the forest, by virtue of its perennial life and persistent height growth, will, wherever it is allowed, drive out other forms of vegetation. Fortunately, many soils and situations which are not fit for agriculture will still yield forest crops of useful description, and in reducing the woodland condition to one adapted to the highest civilization, the relegation of the different soils and sites to the different uses to which they are best adapted, as fields, pastures, or forest, is a problem of true natural economy.

While the most economical use of the soil, for material production, necessitates the relegation of forests to the poorer soils, protective considerations necessitate its relegation to certain localities, and so we have *supply* forests, whose function it is to supply wood material, and, secondly, *protective* forests, which, apart from any yield of produce, are necessary to cover the soil and to regulate local temperature and water conditions.

Dr. Fernow then traces, from the time of Homer downwards, the recognition by men of different ages of the utility of woodlands, until the time came when Sully declared that "La France périra faute des bois," and Colbert's forest ordinance of 1669 was made.

The disappearance of the mountain forests of Italy, France and Germany, and the simultaneous loss of both wood and water, continued apace until the beginning of the XIXth century, when public interest was aroused, and systematic attempts were made in France, Bavaria, Switzerland and Austria, to establish by experiments the exact truth with regard to the influence of forests on soil, climate, and on water supply.

These experiments, however, yielded no very satisfactory solution. Rain-gauges are never to be relied upon, especially where the wind blows, and it is almost impossible to find stations within and without the forest which differ absolutely in no other respect than the forest cover.

The problem is too complicated for our present means and methods to be settled mathematically, and we are thrown back on the method of general observations in the field, and the application of reasoning from well-known physical laws.

The immaterial influence of the forest is claimed to extend in at least four or five separate yet closely related directions.

These are :—

1. Upon the climatic conditions within its own limits, and beyond.

2. Upon the distribution and character of the water flow.

3. Upon the mechanical condition and erosion of the soil under its cover.

4. Upon the health conditions.

5. Upon the ethics of a people.

This last influence is one which may be appreciated only by some, and it certainly cannot be argued about.

In either of the other directions in which the influence of forest cover is asserted, the mechanical obstruction which it represents is the principal effective element.

It is the effectiveness with which wind and sun are excluded from the soil, and thereby the air temperature and humidity modified, that determines the degree and the distance to which this modification is felt. Moreover, the influence is always local, and must only be discussed with reference to local conditions.

Briefly stated, the general tendency of a forest cover is to reduce extremes of high and low temperature, especially of the former, so it has generally a cooling effect. The forest also

acts as a windbreak and by checking the velocity of dry winds, and rendering them cooler and damper, the rate of evaporation over neighbouring fields is reduced, and this protection will show itself in increased crops.

The influence of forest cover on waterflow depends on the topographical and geological structure of the ground, but rests mainly on the fact that the rain and snow waters penetrate more readily a forest-covered soil than a bare one.

The action is threefold; first, the mechanical obstruction offered by the foliage makes the water reach the soil more slowly, and the foliage and litter on the forest floor protect the ground from being beaten hard, and keep it loose and moist; secondly, the mechanical obstruction which the litter and low growth on the forest floor, offer to rapid surface drainage, lengthens the time during which the percolation takes place; and thirdly, the network of deeply penetrating roots, living and dead, offers additional channels for a change of surface drainage into underground drainage.

With regard to the second of these three actions it is evident that the condition of the forest floor is of more moment than that of the leaf canopy, so that grazing and fire will very considerably modify, or may even largely counteract, this influence.

This distribution of the water, which lengthens the time during which the atmospheric precipitations can be usefully employed, and may lengthen the supply for years, renders the riverflow independent of wet and dry seasons, and equalizes its flow.

The influence of the forest on the stability of the soil is very similar, and here too it is the condition of the forest floor rather than of the tree growth which is the effective element.

When the ground is not too steep a simple grass cover may suffice to protect the soil from being washed away by the water, but the forest alone is capable of obstructing the mechanical effect of the rainfall on the soil, and retarding the rapid surface drainage, which becomes the carrier of the débris.

In the United States, it is estimated that the annual amount of erosion amounts to 200 square miles, which shows the importance of a conservative policy for the mountain forests.

In France, any one may see indisputable evidence of the effectiveness of a forest cover, both in arresting the progress of erosion, and also in the fixing of loose shifting sand-hills.

Regarding the sanitary influence of forests, it is probably not true that they increase perceptibly the proportion of oxygen in the air, and their sanitary influence is mainly of a negative character.

The forest air has been found to be free from pathogenic microbes, and the bacilli of cholera, typhus, yellow fever, etc., find

in the forest soil the least favourable conditions for development and distribution.

Here again, it is the condition of the forest floor that mainly determines the degree of effectiveness.

In the appendix of this book, fifteen pages are devoted to a useful and interesting resumé of the details of the meteorological conditions established by experiment in Germany in connection with the influence of forests on soil and climate, both within and without the forest.

Chapter IV.—Forest and Forestry defined.

This chapter begins with a discussion of the etymology of the word *forest*, and traces the historical development both of the word and of the thing thus designated.

The term *woodland* is suggested as the best generic term for land naturally covered with woody growth, in contradistinction to land not so covered; and *forest*, as the specific term for woodlands either natural or artificial, considered from an economic point of view as being placed under management for *forest purposes*, and exhibiting *forest conditions*.

These limitations exclude coffee plantations, orchards, roadside plantings and parks, etc.

The first purpose of a forest growth is to supply wood material, or at any rate part of the wood substance, such as tan bark; but in addition, it is now generally recognized that forest growth serves an object in the economy of nature and of man which may be of even more importance than this direct primary one.

The forest, therefore, has a second important use as a protective cover, and a climatic factor, influencing the soil, temperature, and water conditions of the country in its neighbourhood, and according to whether the one or the other purpose is more prominent, we may distinguish *supply forests* and *protection forests*, and finally when mere ornament, or game cover, are the main object, *luxury forests*.

The forest as an economic factor is not a mere collection of trees, but an organic whole, composed of close crops which exclusively occupy the ground, largely preventing by their shade lower vegetation.

Further, with regard to the first function, it is not merely wood, but wood of useful size and quality, which is required.

The trees must therefore be grown in a close crop, so that all their growth-energy may be utilized in the trunk, resulting in long, clean, cylindrical boles.

A dense crop, and the soil completely shaded, are also the conditions most favourable for the second function of the forest as a regulator of waterflow and climate.

Forestry is defined comprehensively as the rational treatment of forests for forest purposes—not such a good definition, we venture to think, as Mr. Roosevelt's).

Forestry represents a policy, a science, an art, and a business.

A policy, because first of all we have to determine our general plan of conduct with regard to our forests, the motives and object of our programme, and to make up our minds *what* to do with them. Such policy is based on our knowledge of forest growth, in every particular, and in all varying circumstances,—the *why* to do. Formulating this knowledge into rules of procedure, and applying them to our treatment of the forests, we begin to practise the art of forestry—we learn *how* to do; and finally, by applying this art systematically for money results, we practise the business of forestry.

Forest crop production is the business of the professional forester.

A forester, then, is not merely one who knows the names of trees and flowers; nor even one who knows their life-history; nor one who proclaims the need of preserving them; nor one who makes a business of planting parks and orchards; nor one who cuts down trees, and converts them into timber; nor one appointed to prevent fires or depredations in forests; nor even one who knows how to produce and reproduce forest crops; but in the fullest sense of the word, a forester is a technically educated man, who, with the knowledge of forest trees, their life-history, and all that pertains to their growth and production, combines further knowledge which enables him to manage a forest property so as to produce certain conditions resulting in the highest attainable revenue from the soil by wood crops.

Before the finer methods of forest management become practicable, the protection of the natural forest from fire and grazing is the first thing to be done, and this is for the present in many countries the only forestry practicable under existing circumstances.

SYSTEM OF FORESTRY KNOWLEDGE.

I.—FOREST POLITICS. ECONOMIC ASPECTS. (*The Condition.*)

Basis.

1. FORESTRY STATISTICS.—Areas: forest conditions, distribution, composition. Products: trade, supply and demand, prices, substitutes.
2. FORESTRY ECONOMICS.—Study of relation of forests to climate, soil, water, health, etc. Study of commercial peculiarities and position of forests and forestry in political economy.
3. HISTORY OF FORESTRY.—

Application.

4. FORESTRY POLICY.—Formulating rights and duties of the State, forest legislation, State forest administration, education.

II.—FOREST PRODUCTION.
TECHNICAL ASPECTS.
(The Crop.)

Basis.

5. **FOREST BOTANY.**—Dendrology, systematic and biologic forest geography, forest weeds.

6. **FACTORS OF SITE.**—Soil physics: soil chemistry, meteorology and climatology, with reference to forest growth.

7. **TIMBER PHYSICS.**—Physical structure and technical properties of wood. Diseases and defects.

8. **WOOD TECHNOLOGY.**—Application of wood in the arts, requirements. Working properties, use of minor and by-products.

Application.

9. **SYLVICULTURE.**—Methods of producing the crop and influencing its progress.

10. **FOREST PROTECTION.**—Forest entomology, climatic injuries, fires, etc.

11. **FOREST UTILIZATION.**—Methods of harvesting, transporting and preparing for the market.

12. **FOREST ENGINEERING.**—Road building, water regulation, sand dunes, swamps, moors, denuded slopes.

III.—FOREST ECONOMY.
BUSINESS ASPECTS.
(The Revenue.)

Basis.

13. **FOREST SURVEYS.**—Area and boundary, topography, forest conditions, units of management and administration.

14. **FOREST MENSURATION.**—Methods of ascertaining volumes and rates of growth of trees and crops, and determining yields.

15. **FOREST VALUATION, STATISTICS AND FINANCE.**—Ascertaining money value of forest properties, and financial results of different methods of management, and comparing the same.

Application.

16. **FOREST REGULATION.**—Preparing working-plans, determining possibility, and organizing for continuous wood and revenue production.

17. **FOREST ADMINISTRATION.**—Organization of a forest service, business, practice and routine, including forest law, and commercial law applicable to forest practice.

(To be continued.)

The Insect World in an Indian Forest and how to Study it.

(*Concluded from page* 276.)

PART IX.

SUMMARY.

IN the preceding papers on this subject an attempt has been made to briefly describe the various orders of the Insect Kingdom, particular attention being paid to the families of more especial importance in the Indian Forest. If there be any merit in the method in which the subject has been dealt with, it is perhaps to

be found in the fact that the writer has confined himself for examples and illustrations of life-histories of the various insects alluded to under the different Orders and families described entirely to the Indian Region. Elementary works on Entomology are numerous, but it will be found that the authors usually lay under contribution the whole insect world for the representatives they require to illustrate the various families, genera and species described. This is as it should be when the student wishes to study the subject from a general standpoint and not with especial reference to one particular region of the world, and as in the present case with especial reference to the special insect inhabitants of certain definite areas within this region. The task the writer set himself to carry out, as was mentioned in the Introduction, was to consider the subject entirely with reference to the requirements of the Forester in India. The insects mentioned will pratically all be found in one or other of the various forest tracts in the country and all the ones at present known to be of importance have been alluded to in short notes upon what is known of their life-histories, and have been incorporated in their proper places under the genera to which they belong. The writer therefore holds the opinion that the papers may be looked upon as to a certain extent briefly summarising what has been published up to date upon the subject of our more important forest pests.* If the articles are read from this point of view, it will be seen how much remains to be done before we can claim to have any real acquantance with what are our forest insect pests, much less to have a practical working knowledge of their life-histories. That a really good start has been made by the Department in this direction the writer will be the first to readily acknowledge. Several officers are now enthusiastically interesting themselves in the study and it may be said that it was the knowledge that such was the case that led to the necessary time being ungrudgingly given to compile the papers.

But whilst the aim has been chiefly to enable workers to place the insects found by them into their families, this being sufficient for ordinary working purposes, some portions of the various Parts have a much more important significance and this we would wish to briefly draw attention to.

No remarks are necessary upon the Introduction or Part I. Under the *Orthoptera* (Part II) some original information is given in the families *Acridiidæ* and *Gryllidæ*. In the former various locusts are treated of and remedies given for combating their attacks—remedies which it is important that every Forest Officer should know, since he will certainly be called upon to take action when the great migratory locust (*Acridium peregrinum*) is out

* Our knowledge is progressing at such a satisfactory rate however that were the author to rewrite some of the earlier Parts he could include notes upon several other recently discovered important insects.

in its millions, devastating the continent from end to end. In the *Gryllidæ* the large cricket *Brachytrupes achætinus* is alluded to as a pest to young plants.

Amongst the *Neuroptera* (Part III), the only really dangerous pests are the *Termites*, or so-called white-ants, concerning whose actions some remarks are made, with suggestions or protective measures against them.

In Part IV (wrongly called Part III), the *Hymenoptera*, some important original observations are given upon species of the families *Siricidæ* (wood-wasps), *Tenthredinidæ* (saw-flies), Chalcid parasitic flies, Ichneumon parasitic flies (two of which parasitise the teak defoliator, *Hyblæa puera* var. *nigra* Steb. *MS.*, in the Nilumbur Plantations) and Bracon parasitic flies.

In the great order *Coleoptera*, or beetles (Part IV), original observations on life-histories are numerous. They occur under the families *Lucanidæ*, *Carabidæ*, *Staphylinidæ*, *Histeridæ*, *Bostrichidæ*, *Cleridæ*, *Elateridæ*, *Tenebrionidæ*, *Chrysomelidæ*, *Cerambycidæ*, *Curculionidæ*, *Scolytidæ*, *Platypodæ* and *Coccinellidæ*. Of these the habits of some new important predacious *Histeridæ* are described in the papers for the first time. The discovery of a very important predacious clerid insect which feeds upon various bark-borers (an insect closely allied to and which takes the place in our coniferous forests of its German confrére, *Clerus formicarius*, in European continental forests) is alluded to, as is also that of an equally important predacious coccinellid beetle. Amongst pests new bostrichids (*Bostrichidæ*), weevils (*Curculionidæ*), bark-borers (*Scolytidæ*), wood-borers (*Platypodæ*) are discussed. The writer would especially draw attention to the treatment of the family *Scolytidæ*. Up to the end of 1901 but three species of this exceedingly important forest group were known in the Indian Region and practically nothing was known about their life-histories. Notes upon the habits of some 20 (probably) new species have been recorded since that date, of which 14 are alluded to under this family, whilst another four are treated of under *Platypodæ*. In addition some 40 other species have been found, most of which have proved new to science. These still remain to be dealt with, nothing having as yet been published on them. It will be evident that this section alone of the papers is one of the highest importance, since it forms a good basis upon which to build up our knowledge of these minute but dangerous pests.

Amongst the *Lepidoptera—Heterocera* (moths), some original notes are recorded under the families *Sphingidæ* (hawk moths), *Psychidæ* (bagworms) *Lasiocampidæ* (eggers), *Geometridæ* (geometers), *Noctuidæ* (noctuids), and *Pyralidæ*.

The valuable observations made by Mr. T. R. Bell in Bombay, by Mr. R. S. Hole in the Central Provinces, Mr. S. Carr in Burma and others our knowledge of the life-histories of the

two well-known teak defoliators *Hyblæa puera* and *Pyrausta machæralis* is becoming rapidly more complete.

The *Diptera* (two-winged flies) require study since it is becoming apparent that this family contains important gall-making pests. The one infesting the branches of old teak and the leading shoots of saplings in Berar, Madras (Coimbatore), and Mysore especially requires serious attention. This order also includes the *Tachinidæ*, an extremely important family of parasitic flies, which are probably of great use to the forester. One of these has been discovered to infest the teak defoliating pest *Hyblæa puera* in the Nilumbur Teak Plantations.

Lastly, we come to the great order *Hemiptera* or *Rhynchota* (Part VIII), which contains some of the most serious insect pests known in the world. Original observations will be found under the families *Pentatomidæ*, *Coreidæ*, *Reduviidæ*, *Aphidæ* and *Coccidæ*. These latter contain pests whose presence in the forest cannot be looked upon in any but the most serious light, even though our knowledge concerning them is at present but small. The black Aphid upon the Blue pine (*P. excelsa*), and the *Chermes* upon the spruce and silver fir, require most careful study, whilst the Monophlebus scale insects amongst the *Coccidæ* have undoubtedly proved their great capabilities of spreading in a most wholesale manner and committing great havoc over the areas they infest. The Dehra Dun white scale of the sal tree appears to be spreading right through the sal areas of North-West India.

In conclusion the author wishes to express his regret that he was unable to illustrate the articles. He had the intention of doing this since he is well aware of the fact that illustrations are of the very first importance in papers of this nature. The monthly appearance of the Magazine unfortunately precluded all possibility of carrying out this idea. Should it be found possible to re-issue the papers in the form of a small hand-book for convenient use and reference,—and he must leave it to the consideration of his brother officers to say whether it would be useful in this form,—illustrations would be certainly incorporated in the pages of the work.

Report on "Spike" disease among Sandal-wood Trees in Mysore and Hunsur Taluks.

From the Proceedings of the Government of H. H. the Maharaja of Mysore.

1. *May 22nd*, 1903.—Inspected the Yelwal Residency compound sandal plantation, covering an area of about 500 acres. The plantation was opened about 13 years ago and three-fourths of the area stocked with sandal and *Cassia florida* (Sime tangadi), the latter as a nurse. The plants were raised by direct sowings, partly in patches under shelter of shrubs and Lantana bushes and partly in open ploughed-up furrows. The latter have mostly

died out for want of shelter. The cover throughout is very scanty, and those plants which have come up in the open and under the partial shelter of *Acacia leucophlœa* (toppale), *Cassia florida* (Sime tangadi), banyan, casuarina and Lantana are fast dying out, scarcely 10 per cent. being in a healthy condition. Those entirely surrounded by thorny growth have fared better, and on the whole look healthier. At least 95 per cent. of the stock in the open and under partial shelter have either died or are suffering from "spike." At the southern end, under the heavy shelter of mango and other trees, and in low ground, the great majority of the trees are in a healthy condition, but it is scantily stocked.

The locality is outside the natural habitat of sandal. It is higher than the surrounding country and fully exposed. The soil is grayish, consisting of a large proportion of sand and gravel; and the whole area is overgrown with Lantana, which is impenetrable in the southern and western portions. Four diseased trees were marked here in order to study the progress of the disease.

2. At my inspection of this plantation on the 11th May 1901, I recorded the following observations about its condition:—

"In the afternoon inspected the sandal plantation in the Residency compound. Nearly three-fourths of the ground, covering an area of 520 acres, had been stocked with sandal, but during the last two years the deaths have been so heavy that hardly 15 per cent. of the plants are alive at present, due to the same causes as those mentioned already in the case of Hosurmariguai plantation (*viz.*, drought and absence of shelter). The area presents a sad spectacle with its numerous dead and dying saplings. I fear that the whole plantation is doomed, unless there is a change immediately in the climatic condition."

Since then the plantation has changed from bad to worse, and I fear, ere long, sandal will be completely extirpated from the bulk of the area.

3. About 300 yards from the northern limit of the plantation there is a fruit garden in low-lying ground enclosed by a live fence, consisting of Lantana and other species. In this fence and here and there outside it, there are a large number of extremely healthy but pollarded sandal trees, but not a single dead or diseased tree was observed.

4. *May 23rd*, 1903.—Explored the country lying between Yelwal and the village of Dod Margoudanahalli, 8 miles due south of Yelwal. Noticed a number of healthy trees in garden hedges, as well as within and outside gardens. All of them, however, have been heavily pollarded, this pernicious pratice apparently having come into vogue within the last ten years, judging from the length of bole and general condition of trees. No one seems

to have thought it his duty to bring this wilful damage and mischief to the notice of the authorities, and the people themselves do not seem to be conscious of the seriousness of the offence, so free have they been to mutilate this valuable tree without let or hindrance.

5. To the south-east of Bommanahalli, 2½ miles to the south of the Residency compound, there is a date tope of about 150 acres in extent, densely stocked with young sandal, partly natural and partly artificial. The whole area is overgrown with Lantana and thorny growth. At the lower or southern portion of this tract the growth of date is rather sparse and the soil very sandy. Here many dead and a larger number of diseased plants were noticed. Higher up, where the growth of date and other trees is denser and the soil apparently is better, there were very few dead or diseased trees.

6. One large tree over 2 feet in girth, suffering from the "spike" disease in an acute stage, was found about quarter of a mile from the above tract standing in close proximity to two other healthy trees of almost the same size and age. The diseased tree had been cut half way into the trunk and had been otherwise injured.

The diseased tree was marked for observation in order to watch whether it would die or recover, and whether the two healthy trees would get infected by it. It may be noted that all the three trees are situated on low ground in the open, unprotected by any other tree and in close proximity to Lantana bushes. If the disease is infectious, as has been asserted, it must spread to the healthy trees sooner or later. A large dead tree was also noticed within 10 yards of the diseased tree.

7. *May 24th*, 1903.—Explored the country lying between Yelwal and Belagola on the Seringapatam road and Kuraghalli plantation. All along garden hedges, and both inside and outside gardens, sandal occurs in great numbers; and without exception is as healthy as it possibly could be. As a rule, the trees are well sheltered, but sometimes are exposed and isolated. The best bit of natural sandal I have ever seen was met with in a thick date tope which crosses the Seringapatam road at the 87th mile and runs in a narrow strip following the course of a stream north-eastwards.

8. The Kuraghalli plantation, referred to above, is to the right of the Seringapatam road and is only 2½ miles from Yelwal. It has an area of 80 acres and is fully stocked with sandal, which was raised by sowing in open ploughed furrows. The plants are on an average about 5 feet in height. There being hardly any other trees to shelter them, they are fully exposed and consequently are dwarfed and stunted; but no sign of "spike" was noticed. Under shelter near the southern hedge

a few very healthy trees up to two feet in girth were noticed, so also in an adjoining cocoanut garden.

If the "spike" disease is really infectious as has been stated, it is strange that it did not spread to the adjoining gardens and the Kuraghalli plantation.

9. *May 25th*, 1903.—Explored the tract of country lying to the south of the Yelwal-Bilikere road. No sandal occurs from Yelwal to Handanhalli, a distance of 5 miles, but at the latter village there is a patch of natural sandal covering an area of about 600 acres, resembling an artificially stocked plantation. The area forms the head-waters of a small stream, the ground is depressed, forming a sort of dip, and the soil, which is stony, consists of gravel and sand.

Sandal, though not presenting the same healthy appearance as in more favoured regions, does not show any sign of "spike" or any other diseases, though it has been hacked and pollarded for goat-browsing. The trees rarely exceed 15 feet in height and two feet in girth. Saplings under one foot in girth predominate.

The auxiliary and accessory species with which sandal is found associated are: *Anogeissus latifolia* (dindiga), *Celastrus montana* (dante), *Ixora Parviflora* (gorvi), Lantana, *Acacia catechu* (kagli), *Acacia leucophlœa* (toppale), *Pavetta indica* (pavate), *Diospyros ebenum* (tupra) and several other species, the whole forming a fairly dense scrub. The growth of Lantana is nowhere heavy and parts here and there are free from it. All the trees, including sandal, are stunted and deformed, a condition due, undoubtedly, to the poverty and shallowness of the soil.

10. From Handanhalli to Chika Bichanhalli, and from the latter to Dod Bichanahalli and Yelchodi, a large number of healthy, but heavily pollarded and scattered trees, were noticed in the open fields, gardens and date topes. Those in the open seemed less healthy, evidently owing to the clearing of the surrounding vegetation and isolation. As stated elsewhere, the people have been openly lopping off branches of sandal trees for feeding goats, with impunity. That none of these tracts had ever been visited by any Forest official is clear from the fact that the patel of Dod Bichanahalli could not make out that the Forester and two Forest Guards accompanying me, and who were in full uniform, were Forest employees. The shekdars and village officials apparently think that it is not their business to prevent such wanton damage and mischief. The matter will receive my earnest attention and a regular crusade will be waged against goat-herds.

11. *May 26th*, 1903.—Explored about 40 square miles of country to the south of the Bilikere-Hunsur road.

Scattered and pollarded, but perfectly healthy sandal trees were noticed in the gardens, fields and gomals of Jinhalli and Dallal. In the gomal lands of Chilhalli there is a dense strip of sandal mostly young, but with big trees here and there in a small valley, growing in the midst of dense scrub and Lantana. The soil and composition of the stock are the same as in Handanhalli already described, but the sandal looks healthier and more vigorous, especially in the dense thickets. Healthy and scattered sandal is met with in the fields and gardens throughout, those in the gardens being healthier and more vigorous than those in the open fields. Nearly all the latter appear to have grown up under the shelter of trees and shrubs in hedges. With the extension of cultivation and adoption of improved methods of farming, the hedges and trees have been removed and the sandal now stands isolated and exposed.

12. Immediately to the south of the Hunsur road and in the midst of dense scrub and thorns an extensive area covered with excellent sandal, composed of all ages and sizes, is met with. This area forms part of the proposed Arabitittu reserve. Further south the vegetation is stunted, soil more exposed and the sandal occurs sparingly.

Wherever the vegetation is healthy and dense and the soil fairly rich and deep, sandal is met with in its healthiest state, and where the vegetation is stunted and sparse and the soil hard and shallow, it looks sickly, being clothed with pale-coloured narrow leaves.

13. We came this day across two trees with characteristic spiky leaves, one near a hut with all but one or two roots cut off, and the other an aged one, growing by the side of a sheet rock. Both the trees had been heavily pollarded and looked very aged. They are slowly dying out, and the small diminutive leaves are evidently indications of impaired health and vigour and not of any specific disease.

14. *May 27th*, 1903.—Inspected the Hosurmarigudi plantation and the forest to the north of the Bilikere-Hunsur road. The following notes were made about the condition of the Hosurmarigudi plantation at my inspection on the 9th May 1901:—

"Inspected the Hosurmarigudi sandal and gallnut plantation (500 acres). Judging from the number of dead and dry saplings the plantation appears to have been thickly stocked with sandal at one time, but now hardly 10 per cent. are alive. Those in sheltered valleys and under shelter have not died to the same extent. Mr. Theobald, who accompanied me during the inspection, attributes the heavy casualty to the disease which Mr. McCarthy calls "spike." I think it is more due to the severe drought experienced during the past three years. The

subject will be further investigated and a report submitted on the result of the investigation."

The plants were raised partly by dibblings under the shelter of bushes and date trees and partly by sowing in open ploughed-up furrows with *Cassia florida.* The *cassia* has died out, and the sandal that was raised with it is stunted and unpromising. The dibblings under bushes and trees have given better results, and the saplings on the whole are as healthy and vigorous as could be expected, having regard to the poverty of the soil and stunted scrubby vegetation. The whole area of the plantation and surrounding tracts were carefully searched in separate parties by myself and Messrs. Benson and Muthiah, but not a single spiked tree was noticed. Nearly all the plants which looked half dead at my inspection of two years ago have recovered. And the plantation has now the appearance of a well-stocked area.

15. Sandal is found scattered throughout from Bilikere to Hunsur, but hardly any dead and no diseased trees were noticed.

16. In the evening I was taken over by Mr. Petrie Hay, who takes a keen interest in the "spike" disease, and shown an acutely infected area, a mile to the west of the Hunsur Travellers' Bungalow on the Coorg road. All the trees that stood on it have died or are dying out, but hardly any diseased trees are noticed between the Travellers' Bungalow and the infected area. To the west and south of the latter, also, there are a few or no diseased trees, while to the north they are found sprinkled here and there. The tract is covered with Lantana.

The diseased and unhealthy condition of the sandal in this tract, apparently, is due to frequent fires in Lantana thickets, in the midst of which it grows, and unsuitability of the sub-soil, which here consists of a substratum of "Kankur." All the other species associated with sandal have also a sickly look and are more stunted than sandal. It is, therefore, no wonder that sandal, the most sensitive of all, has suffered to a greater extent.

17. *May 28th*, 1903.—Explored the tract of country lying between the Hunsur-Bilikere and the Hunsur-Heggaddevankote roads.

There is a scrub jungle consisting of the usual deciduous species and Lantana thinly scattered. Sandal is met with here in great abundance, and in places forms 50 per cent. of the stock. The growth is nowhere dense. About half-a-dozen dead trees were noticed, but no diseased ones, except in a small patch on the slope of a low hill where all the trees have died or are dying. The soil in the patch referred to is hard and stony. It is surrounded on all sides by perfectly healthy trees growing on deeper and better soil.

Also noticed two sandal trees in the midst of healthy ones entwined and suppressed by thorny climbers bearing the charac-

teristic spiky leaves, showing that the spiky condition of the leaves is not the characteristic feature of any particular disease, but is only a sign of natural decay owing to old age, enfeebled condition of the root system, strangulation or suppression.

18. In the evening Mr. Petrie Hay again took me and showed a number of trees about $2\frac{1}{2}$ miles to the south of the Hunsur town on the Heggaddevankote road, suffering from the "spike" disease. We saw 3 or 4 trees growing under favourable conditions and in the midst of perfectly healthy ones with markedly spiky leaves. The locality is overgrown with Lantana and is subject to annual fires. I am inclined to attribute the diseased condition of the trees referred to to the effect of fire on the surface roots of sandal.

19. *May 29th,* 1903.—Explored the country lying between the Hunsur-Hanagod and Hunsur-Coorg roads.

Fine healthy sandal trees were noticed up to a mile of the Hunsur Travellers' Bungalow. Afterwards a number of dead and diseased trees were noticed for quarter of a mile along Lantana hedges and in the adjoining scrub jungle, very few being noticed to the south of the Hanagod road. Then, no diseased trees were observed until the 6th mile from Hunsur, where a few diseased and dead trees were noticed in the fields. All the dead and diseased trees were standing exposed and isolated, and from their position it would appear that they grew up in the midst of other growth. Not a single tree growing in the midst of shrubs and trees was found diseased. Again, a large number of dead and diseased trees was met with in the fields of Tattekere village. To the north of this village up to Kallabetta on the Coorg road sandal abounds in the scrub jungle, but no diseased trees were observed. Sandal also abounds in the scrub jungle in the vicinity of the Kallabetta Police Station, but no spiked trees were noticed. The soil throughout this tract, as may be judged from the condition of the vegetation, is poor, stony and shallow, but the forest growth is better than that met with in the diseased tract further east. There is also less Lantana.

Noticed a fairly big tree completely encircled and covered by a thorny climber, bearing spiked leaves.

20. *May 30th,* 1903.—Inspected the Kallabetta State Forest to the right of the Coorg road and the sandal growth from Hunsur to Periyapatam.

In the State Forest, for about 2 miles from the Hunsur Travellers' Bungalow, diseased trees are frequently met with and form about 5 per cent. of the stock, but beyond that no diseased trees were met with. In the State Forest, the forest growth associated with sandal is extremely scrubby and stunted, all the trees having a sickly look with the leading shoots and tips of branches dead. Sandal towers above all, and may be seen from

a distance, so there is very little protection for it. This miserable condition of the entire stock, undoubtedly, is due to the poverty of the soil, which is stony and shallow. Where the trees are fully sheltered, sandal is as healthy as could be desired.

21. Sandal is found scattered along the edges of fields and in gardens between Kallabetta Police Station and Periyapatam. Those on fields are generally exposed, and consequently bear pale-coloured leaves; while in the gardens they are invariably healthy, the best and most vigorous trees being found there.

Most of the isolated and exposed trees have had their outer bark and cortex facing south-west scorched, so as to leave the heart-wood along the whole length of the bole bare, a result due to severe exposure to sun and wind.

22. Examined the sandal trees in the Periyapatam Travellers' Bungalow compound and in the gardens close by. At the southern boundary of the compound a number of unhealthy-looking trees were noticed in the Lantana hedge, unsheltered by other trees, but they did not seem to be suffering from any particular disease. Along the northern hedge of the compound there is a row of very vigorous sandal trees in the midst of *Cassia florida* and banyan.

In the hedge of a garden to the west of the compound there was a suspicious looking tree which was marked for observation.

All the exposed and isolated sandal trees have had their bark and cortex along the whole length of the bole facing south-west scorched and peeled off, leaving the heart-wood exposed. Some splendid specimens of sandal trees were found in the hedge of a garden below the Periyapatam tank.

23. *May* 31*st*, 1903.—Explored the country lying to the south of Periyapatam and situated between the Hunsur-Anechowkur and Periyapatam-Anechowkur roads.

Sandal is found in great numbers at the edges of fields and in the scrub jungle outside them. Those in the fields stand exposed and isolated or in the midst of Lantana. Only 4 or 5 dead and a dozen diseased trees were noticed, all of which were either standing in the midst of Lantana or once were growing in that condition. Also noticed a number of trees killed outright by recent fires. I have little doubt that the diseased condition of the trees noticed by me is due to the annually recurring fires which are purposely started by the villagers in the hot weather to destroy the Lantana. In the scrub jungles which are subject to heavy grazing, and where Lantana is not much in evidence, fires do little or no harm; and here no diseased trees are met with.

24. In the Panchwalli plantation covering an area of about 100 acres, which is fairly well stocked, three young saplings were found in the midst of healthy ones with spiky leaves. Similarly,

a few diseased trees were noticed about 2 miles from Periyapatam in the midst of Lantana hedges and thickets.

25. *June 1st*, 1903.—Explored the country lying between the Periyapatam-Virarajendrapet and Periyapatam-Fraserpet roads.

Fine healthy sandal trees were noticed for a distance of 5 miles from Periyapatam in fields and garden hedges and a few scattered trees to the north-east of Muttur village. Then we came across a small patch of diseased and dead trees in the fields of Lalapur village. To the north and east of this patch healthy trees again occur up to the Fraserpet road. From the 127th mile to the 129th mile of this road a large number of dead and diseased trees were noticed in the midst of Lantana, forming about 40 per cent. of the stock, except to the south of the 129th mile, where an acutely infected area in the midst of dense Lantana thicket is found. It was also noticed that sandal trees-under the heavy cover of fig trees in the avenues had died off, apparently from heavy cover, dampness and drip. The surviving ones have an extremely unhealthy look, with the top branches dead and scanty leaves, but none of the leaves had the appearance of "spike." Near the 130th mile a splendid specimen of sandal was noticed with spiky leaves and with its whole crown covered by a thorny climber. Close to it there were a number of fine healthy trees.

From the 131st to the 135th mile at the Cauvery, very few sandal trees dead or diseased were noticed on the roadside, except in an Inam jungle, where a number of healthy and diseased saplings were observed. The disappearance of the sandal in this locality might be traced to severe fires in Lantana thickets, it being the usual practice in these parts to get rid of this pest by firing in the hot weather.

26. *June 2nd*, 1903.—Explored the tract of country lying between the Cauvery river and the Fraserpet road up to the northern boundary of the Dodharve State Forest. This tract of country is very familiar to me, having passed and repassed through it scores of times between the years 1878 and 1885 on my way to the Coorg Forests further south. Then it abounded with most vigorous sandal trees; but Lantana had not invaded to such an extent as at present. Now the whole tract, except the cultivated fields, is covered with a dense tangled mass of Lantana, which year after year is burnt down to come up again with renewed vigour at the beginning of the following monsoon. The fires have almost exterminated the sandal. I noticed only a few healthy trees on the banks of the Cauvery and in a small patch under heavy shelter between the villages of Girgur and Dodhosur. Trees standing on the edges of fields had a spiky or diseased look about them, which may be due to isolation and exposure or fire.

Further south, where tree growth is fairly dense, sandal is met with sparingly, and only two diseased saplings were noticed; thus showing that where the cover is fairly dense and forest fires are not severe by reason of the comparative absence of the undergrowth, sandal is not subject to any disease to any appreciable extent.

27. *June 3rd*, 1903.—Explored the tract of country lying to the north of the Fraserpet road from the 135th mile to the 130th mile.

On the bank of the Cauvery there are two sandal trees under the shelter of a bamboo clump. In one of them half the branches contain the characteristic "spike" leaves and the other half healthy ones. In the other only twigs, here and there, are affected. Both these trees have been marked for observation. In the same row there are five or six healthy trees, but at some distance from the two unhealthy ones. Further on, towards the north and east to a distance of two miles from the Fraserpet road, not more than half-a-dozen diseased trees were met with. Here sandal, though not plentiful, is met with in fairly large numbers, especially in the hedges. Where the hedges consist of trees and shrubs with or without a mixture of Lantana, the sandal, as a rule, is extremely vigorous and healthy—especially where the soil is rich and deep. We came across several saplings in Lantana killed outright by fire. In the tract inspected not even one tree in a thousand was diseased.

28. *June 4th*, 1903.—Explored the tract of country situated between the Periyapatam-Hunsur and Anechowkur-Hunsur roads.

Sandal is met with scattered in the fields, exposed and isolated, and consequently in a sickly condition.

The scrub jungle outside the fields is rich in sandal, but the trees are usually stunted with contracted crowns, the latter condition evidently being due to heavy pollarding for goat browsing. The other species composing the stock are also stunted, deformed and unpromising.

Some healthy and vigorous sandal trees were noticed in the midst of bushes towards the Panchwalli road. Two exposed trees with spiky leaves were noticed in close proximity to other healthy rees. These were the *only* diseased trees noticed during the day.

Under the heavy shade of fig trees in the avenues a number of dead and dying trees were met with, they having died apparently from the same causes as those mentioned under date 1st June.

29. At Hunsur, examined a number of healthy, diseased and dead trees experimented upon by Mr. Benson under my instructions, the details of which are as follows:—

(*a*) One perfectly healthy tree standing in the open was girdled in order to watch the formation of new shoots and leaves and changes in their appearance and size.

(*b*) One perfectly healthy tree standing in the open had all the lateral roots cut out and the excavation filled up with stone and earth.

(*c*) One perfectly healthy tree standing under shelter was similarly treated.

(*d*) Several diseased trees were uprooted in order to see to what distance the roots extend and ascertain the cost of uprooting. The root of one tree was found to extend as far as 55′, crawling just below the surface, and afterwards was lost in the bund of a tank. Judging from its thickness, its total length cannot be less than 100′. In another case the root extended to 45′. The tap-root as a rule is not more than 5′ from the surface.

The cost of thoroughly uprooting diseased trees of about 2′ in girth amounts to about 12 annas per tree. If the work is conducted on a large scale it could, probably, be reduced to about four annas. Dead trees would cost much less.

(*e*) Examined also the root system of two healthy seedlings in order to see how the "haustoria" of sandal roots attach themselves to the roots of other trees.

30. *June 5th*, 1903.—At Yelwal I had some diseased saplings cut, in order to see how their wood differed from that of healthy ones. Twelve diseased and one healthy saplings were cut; five of the former had holes bored right through the entire length of the stem, showing that some boring insect was at work, while the latter was in perfect condition.

Specimens of sandal borers recently sent to the Indian Museum at Calcutta from the Devarayadurg Forest of the Tumkur District were identified as the larvæ of the moth *Zeuzera coffea*.*

The insect attacking the sandal trees at Yelwal probably belongs to the same species. Whether the insect begins its attack when the tree is in a healthy state or after decay or disease had set in, is a moot point and requires further investigation.†

31. A map illustrating the areas inspected and the distribution and condition of sandal trees is appended to this report. A study of this map will not fail to lead to the conclusion how erratic the course of the "spike" disease is, if it is, at all, a specific disease. A number of photos and a water-coloured sketch,

* The specimen sent was in a small top or branch which it had hollowed out.—HON. ED.

† We would refer the Acting Conservator to the note on sandal-wood borers published in the *Appendix Series* with last month's number of the Magazine.—HON. ED.

showing the condition of spiked leaves and trees, kindly lent by Mr. Benson, are also submitted herewith.

CONCLUSIONS.

32. After a careful study, extending over 15 days, of the diverse conditions under which sandal is found to grow in the tracts inspected, I have arrived at the following conclusions:—

(a) That "spike" is not a specific or definite disease.

(b) That the narrow, diminutive and bristle-like leaves found in the so-called spiked trees are not peculiar to any specific form of disease, but are commonly found in all trees dying from the following causes:—

(1) *Old age.*

(2) Injury to the roots by fires or hurt.

(3) Suppression or strangulation by climbers.

(4) Fungoid, parasitic or epiphytic growth.

(c) That spiked trees are always met with only in heavy Lantana thickets, which are liable to be annually or periodically burnt.

(d) That poor or shallow soil or soil containing a great admixture of 'Kankur' or resting upon a substratum of 'Kankur,' induces premature decay of the root system and consequently of the tree.

(e) That areas liable to be submerged and water-logged soils are inimical to the growth of sandal.

(f) That sandal-wood sooner or later be *exterminated in* tracts containing dense growth of Lantana, owing to the liability of the latter to be burnt down by fire; sandal being a sensitive plant and surface feeder is least able to withstand the effects of fire.

(g) That "spike" is neither a contagious nor infectious disease, for if it were an infectious and communicable disease it is difficult to explain why it is confined only to particular localities or occurs only in scattered patches and amongst scattered trees *in the midst of healthy ones.* It cannot be said that the disease has not had enough time to spread to other trees or other areas, because according to all accounts it has been in existence for at least seven or eight years.

(h) That trees standing in the midst of thick scrubby growth or under the shelter of light-crowned trees and in the rich soils of gardens enjoy a total immunity from the disease.

(i) That sandal *has always an unhealthy look* where the vegetation associated with is unhealthy; and where the latter is healthy and vigorous, diseased trees are never met with.

MEASURES UNDERTAKEN FOR THE ERADICATION OF DISEASED TREES.

33. Whether the disease is infectious or not, it is beyond doubt that once a tree shows signs of spiked leaves in an advanced stage, it never recovers. It has, therefore, been considered advisable to uproot all such trees. For this purpose I have posted two intelligent and active Rangers, two Foresters and eight Forest Guards to the Hunsur Range with instructions to carry out the following operations:—

(a) To carefully explore the sandal tracts in the Mysore and Hunsur Taluks and show their exact positions in the taluk maps, using distinctive symbols to indicate healthy and diseased trees as well as density.

(b) To prepare a descriptive account of each tract, stating the conditions of soil and vegetation in which healthy and diseased trees are met with.

(c) To uproot all dead and diseased trees in the two taluks and any that may be noticed in the adjoining taluks within 5 or 6 miles of the borders.

(d) To burn all the debris and unmarketable portions of the trees on the site, and to hand over to the custody of village officials all marketable wood.

34. As the number of trees to be uprooted is not large and is confined to particular localities, I do not anticipate that the cost of the operation will exceed three thousand rupees, which will be repaid ten times over by the sale-proceeds of the marketable wood which, if not removed promptly, stands in imminent risk of being destroyed by fire. The whole operation, I expect, will be completed in three months. Stringent instructions have been given to the local staff to uproot all the dead and diseased trees within a radius of 5 miles of the Hunsur town within one month.

35. Detailed instructions have been issued to all District Forest Officers to make a close inspection of sandal tracts with a view to discover whether the disease has made its appearance in their districts and to uproot any diseased tree that may be met with.

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Cooper's Hill as a Training College for the Imperial Forest Service.

A GOOD deal has of late appeared in the papers and elsewhere on the subject of the continuance of Cooper's Hill—that College on the Hill situated in one of England's fairest counties and overlooking one of the loveliest of the vales of Father Thames. All that has appeared on the subject, however, has been strictly in connection with the Engineering side of the College. Since this is by far the larger portion of the Institution, which came into being in order to provide specially trained Engineers for the Indian Service, this is perhaps only what was to be expected. At present, therefore, it would appear that the future maintenance of Cooper's Hill, whether it is to stand or drop, as in the case of Haileybury and other famous institutions of old, into the limbo of the past depends upon whether the officers of the Public Works are to be specially trained for that great Department at a Government college or whether they shall in future be recruited in the open market. With the arguments for and against this side of the question we shall not here concern ourselves. It is our intention to examine the advantages of the College as a training ground for the Officers of the Imperial Forest Service and to compare the training obtained under the present régime with that available at one of the great Universities.

Since 1885, a period of 18 years, all the Officers of the superior branch of the Forest Service have been recruited from Cooper's Hill, *i.e.*, they have won their provisional appointments in public competition and have then been sent to Cooper's Hill to be specially trained in the work of their future profession. Until 1890 the period spent at the College was five sessions, followed by a four months' tour in the forests of Germany, two years in all. The students who passed the public examination in 1890 spent eight sessions at the College, from September 1900 to March 1903, followed by a four months' tour in Germany,

a total of three years. It having been decided that the German tour did not produce all the results desired it was abandoned the following year. Under the new régime the students remained in residence at the College during seven sessions only, proceeding to Germany in the January of their third year and spending six months working in pairs under specially selected German Forest Officers, their work being under the general supervision of that eminent forester, Sir Dietrich Brandis. This programme was again changed some years later, and the students now spend nine months in Germany, proceeding there at the beginning of the seventh session (October) and remaining until the middle of the following July. Of this period eight months are spent in pairs working under the supervision of a local German Forest Officer, whilst the ninth is devoted to touring, under the able guidance of Dr. Schlich, through specially selected areas in the Black Forest and elsewhere. Previous to 1891 the students used to visit at the end of their first year some selected Scotch forests. On the death of the owner this plan was altered, and the students of the 1890 year visited, at the end of their first year, some French forests in Normandy. This practice has been continued to the present day. In addition, various small forests of interest in England are visited from time to time during the sessions at the College.

The course of lectures at the College comprises Forestry, Botany, Entomology, Geology, Chemistry, Law, Forest Engineering, Drawing, Surveying, Accounts and German. Forestry in all its branches is taught by Dr. Schlich and Mr. Fisher, whilst carefully selected Professors teach the other subjects.

Owing to the wide range and nature of the subjects studied, the Forest students who obtain the College diploma have, we consider, received a scientific training which enables them to rank with any University graduate who takes a scientific degree, whilst the former are in addition equipped with information of a special kind which qualifies them to fill posts in a special Service. Whether the special training required to turn out the young Forest Officer could be equally satisfactorily given at one of the great Universities is open to considerable doubt. We propose to marshall a few reasons in support of this opinion, and also to point out some of the advantages of the present system of training as enjoyed at Cooper's Hill.

It has been suggested at various times that it would be better to send the Forest students to either Oxford or Cambridge, a special Chair of Forestry being created at one of these great Universities. At first sight this proposal appears both alluring and advantageous, but when subjected to careful scrutiny, there can, we think, be shown to be considerable drawbacks to its initiation. A large number—perhaps the greater number—of University graduates go up, not with the idea of qualifying themselves for a special profession, but with the sole idea of

obtaining their degree. This is all that the College Lecturers aim at. The after-professions of these students do not usually interest them in any greater degree than they do the greater number of the Heads of Public Schools. The one idea of these latter is that their boys should obtain a scholarship at one of the Universities and go up there. This reflects credit on the School, and the subject of the real after-life's work of the boy is left out of consideration. The honour of the particular School or of the College or 'Varsity is the chief thought, perhaps naturally so, of both Head Master and College Professor. But this sort of teaching is hardly suitable for men who wish to follow a special course of study to qualify themselves for their life's profession, and more especially when that profession is one so little understood in England as that of a Forester, and is to be followed in a foreign land where conditions are so totally at variance with those amongst which they have been brought up Two instances of a similar nature may be mentioned. Neither the military nor the medical man goes to either of the great Southern Universities. Both have to render themselves efficient in a special profession and it has been long recognised that this cannot be accomplished at either Oxford or Cambridge. The training of the Forester is not one whit less technical than that of either of the above mentioned professions. The Government of India naturally expect and require that the men sent out should have been as fully and carefully prepared as can be done at Home. The Cooper's Hill course on its present lines would seem to afford such training in its highest and most efficient form.

In considering its advantages we may first briefly allude to a most important part of the training of all youngsters designed for a "Service," and that is the training in discipline. The College life affords opportunities of implanting early a sense of discipline in the future officer, whilst at the same time generating an *esprit de corps* which, whilst making for good in the Service itself, is, we think, a by no means negligable asset from a Government point of view in a body of its servants. The first point is one of the greatest importance. Whether the Service be a Military or Civil one, it is essential for its efficiency that discipline should be maintained within its ranks. To be effective it is necessary that this discipline should be inculcated at as early an age as possible. It is well known that the discipline maintained at or learnt at one of the Southern Universities is far from being all it might be. The under-graduate lives out in chambers, has practically no supervision exercised over him, and works or not pretty much as he pleases. The same with the *esprit de corps.* Men scattered through a number of distinct Colleges, or only meeting in lecture-rooms, are not bound together afterwards by that tie which unites men who have lived together under the same roof through three of what are perhaps the most impressionable and most receptive years of their lives. Both the discipline and

the *esprit de corps* of the old Haileybury men are well remembered in India, and we think that much the same feeling exists amongst the men who come from the College on the Hill. Further, it by no means follows that by a sojourn at a 'Varsity any special social advantages are necessarily enjoyed. Having considered the efficiency of the students as affected by discipline and *esprit de corps*, we now come to a consideration of the efficiency of the training obtained at the Institution in question as compared with that obtainable at Oxford or Cambridge.

From the outset the important subjects of Forestry and Botany are dealt with in a full and broad manner, whilst the lectures in the former are rendered all the more valuable by the fact that they are delivered by Anglo-Indian professional Foresters, who after a distinguished career passed in actual charge and administration of the forests of India, have devoted themselves to the training of those who are to work in the field they themselves have spent so many years in. The accompanying subjects of Law, Geology, Chemistry, Forest Engineering, Entomology, etc., are all grouped round the above two, and are taught in a manner which at once shows their connection with the chief subjects—a point to which it is essential the Forest student's attention should be drawn. Drawing, Surveying, Accounts and German are other subjects included in the curriculum, and in two at least of these the Forest student requires not only a sound but also a special training. It would not be sufficient for him to learn elementary principles only, as imparted by the Lecturer in a University with a view perhaps to the student taking up subsequent research in this one particular branch. The Forest Officer does not require to attend a large number of lectures on elementary principles, followed by others dealing with the more abstruse portions of any particular subject. He requires these elementary principles, but he requires them to be given to him in the light of their bearing upon his future professional work. He does not require, *e.g.*, Botany lectures with a view to his becoming a specialist in that subject. Sufficient for him will it be if he is able to place his trees and plants into their families and genera. The Botanist is ready to do the rest for him should he come across new, or to him unknown, species. For this reason he requires a good, sound and to some extent a more or less special course in this subject. As it is with Botany so with Entomology, Geology and kindred subjects. The Forest specialist is necessary in these various subjects, but we are not here considering the question of the training or knowledge required by that officer, but of that of the men who will be actually engaged in looking after and working the forests. The question for consideration is, therefore, the pertinent one—Would students following the ordinary course of lectures at one of the Universities have as good a training, and therefore prove as good officers, as those who

had followed what practically amounts to a special course in each branch of the various subjects taken up? This question is a most important one, for the well-being of the Service is closely bound up with the training received by the superior staff recruited from Home. The answer we think can only be given in the negative.

Having briefly considered how the theoretical part of the Forest student's training can be more advantageously given at such an Institution as Cooper's Hill, we now come to a consideration of an equally important part of the work, the practical course. It has been often advocated that such can only be really efficiently obtained in a Continental forest, and the acceptance of this principle has resulted in the practical German course at present gone through by the students and which has been declared sound by the experts—all former Inspector-Generals of Forests in India—who drew it up. A considerable amount of the more elementary practical work is however gone through at Cooper's Hill. Briefly, the practical work whilst at the College consists, as we have already seen, of short visits to various experimental areas of forests in England, paid at different periods during the College course, with a short tour to some forests in Normandy in France at the end of the first year, in addition to the work done at the College and in the neighbourhood. If Cooper's Hill and its neighbouring woods had been specially designed by Nature for the instruction of budding Foresters in the principles of elementary sylviculture they could have scarcely been bettered. Nurseries, young plantations, high forest (with many examples of how it should not be managed) and a profusion of exotic trees enable the Forest Professors to illustrate their lectures, or set the students to practical work, at the very doors of the College itself, and the students have thus the advantage of having these illustrations ever before their eyes. Areas further afield in the country serve to illustrate various other points brought out in the lectures. The training at Cooper's Hill used to include the management by the Forest professorial staff and students of the neighbouring Cæsar's camp forest. This formed a most valuable aid to the College curriculum as, in addition to obtaining in it much practical information about their work, the students used to prepare by themselves a working-plan for this area. Owing to the heavy rent demanded by the Commissioners of Woods and Forests for this forest it was given up, and an excellent training ground was thus lost to the students. This being the practical part of the course as obtainable at Cooper's Hill, we would ask—How could such be given at a University? It is the compactness of the present Institution and the close intimacy existing between teachers and taught which enable the students to so readily and easily absorb the mysteries of sowing and planting and the more elementary principles of sylviculture—all of which can be explained again and again, with numerous illustrations in the

very grounds of the College itself or in the adjoining Windsor Park and Forest. Can, we would ask, either of the Universities show even a tithe of the peculiar advantages which Cooper's Hill affords for the instruction of the young Forester? Having followed this initial elementary course the students are then in a position to take the fullest possible advantage of the Continental practical work. We are unable to see that such a training could be improved upon, or even carried on at all, upon its present lines at one of the Universities.

If there is a tiny rift within the lute at present, it is to be found, not in the training of the students after they have obtained their provisional appointments, but in the methods by which these are obtained. There are two points connected with the present manner of obtaining recruits for the Service which we think would bear revision. Until a few years ago nomination was necessary before permission was granted to appear at the competitive examination. This nomination was of value, since it permitted selection and thus enabled permission to appear to be refused to men who were obviously unfitted for a forest life. We should be glad to see this system of nomination returned to, since it has appeared that it was obviously a sound one. The second point is to be found in the examination subjects. In the old days the examination itself was of a nature to test a competitor's fitness for his life's work. Not only had he to take up subjects closely connected with his after profession, but the securing of an appointment could only be attained by obtaining certain minima of marks in these subjects. Now the competitor can pass in on Classics and Higher Mathematics, only to find that he has no aptitude and no liking for the subjects of his profession. Such a one can neither be made nor make himself into a Forester.

We have endeavoured to show above that the training as at present given to Forest students at Cooper's Hill is eminently a satisfactory one,* and granting this, it follows that the question of the abolition of the College affects the Service in India very closely. It may therefore not be out of place to briefly call attention to a point which is worthy of serious consideration. Would it be feasible, in the event of the Engineers required for the P. W. D. in India being no longer recruited from Cooper's Hill, to use the College as entirely a Forestry one, to form,

*It does not fall within the scope of this article to consider the great advantages which a further course of training on arrival in this country would confer upon the newly-joined young Forest Officers. An additional few months' course, with visits to selected typical forest areas in different parts of the country, would do much to prevent men from falling into the error of thinking that their own division and particular class of forest are the only ones they need think about or care to know anything about (a habit which one is perhaps only too apt to acquire), besides giving them a general knowledge of the various classes of forest and different conditions pertainable in different parts of the country.

in fact, an Imperial Forestry College for the Empire at large, a College in which young would-be Foresters could be trained alike for service at Home (under the new afforestation schemes we have read so much about recently in the Home papers), in India and the numerous Colonies? Indian Forest Officers, either retired or still borne on the Departmental lists, are now serving in several of the great Native States in India itself, in Ceylon, at the Cape, in Nigeria, Egypt, Trinidad, Straits Settlements, Siam, Federated Malay States and elsewhere about the world. Could not an Imperial Forestry College in the old country train the men required to manage these vast and valuable forest estates? Surely our great Colonial Secretary would be ready to stretch out a helping hand towards the maintenance of such an Institution, and Cooper's Hill and the Imperial Forestry College would not then be a burden to be borne by the Indian Government alone. The British Empire took up the Forestry question years before the Americans paid any attention to their forests, except to the details connected with cutting them down, and yet this latter nation bids fair to leave us far behind in this important branch of administration. For a search through the countries, cities and towns of our vast Empire will, we think, reveal but one Institution devoted solely to the teaching of Forestry and the training of Foresters, and that one the Imperial Forest School located at Dehra Dun, maintained by the Government of India and under the management and teaching of officers of the Imperial Forest Service. This School, as is well known, provides for the requirements of the Provincial Service in India and to a certain extent for those of some of the Colonies who are taking up the Forestry question. We would ask—Could not the Imperial Forest School of India be supplemented by the Imperial Forestry College of England, and would not the formation of such a College be worthy of, and in consonance with, the true needs of the Empire?

The Kheri Trans-Sarda Forests (United Provinces).

BY F. A. LEETE, F.C.H.

THE May number of the *Forester* contains some "Notes" by "H. J." on his tour through the Kheri Division with the Forest School students in January last.

A little over two years ago I was in charge of the division, and the new working-plan for the Trans-Sarda forests was drawn up by me. I should like therefore to make a few remarks about the "Notes."

TRANS-SARDA FORESTS.

(a)—CONFIGURATION.

In the description of the *sal* forests given in the working-plan, an attempt is made to show that configuration plays an

important part even in an apparently level country. Two types of forest, "High Level" and "Low Level," are recognised.

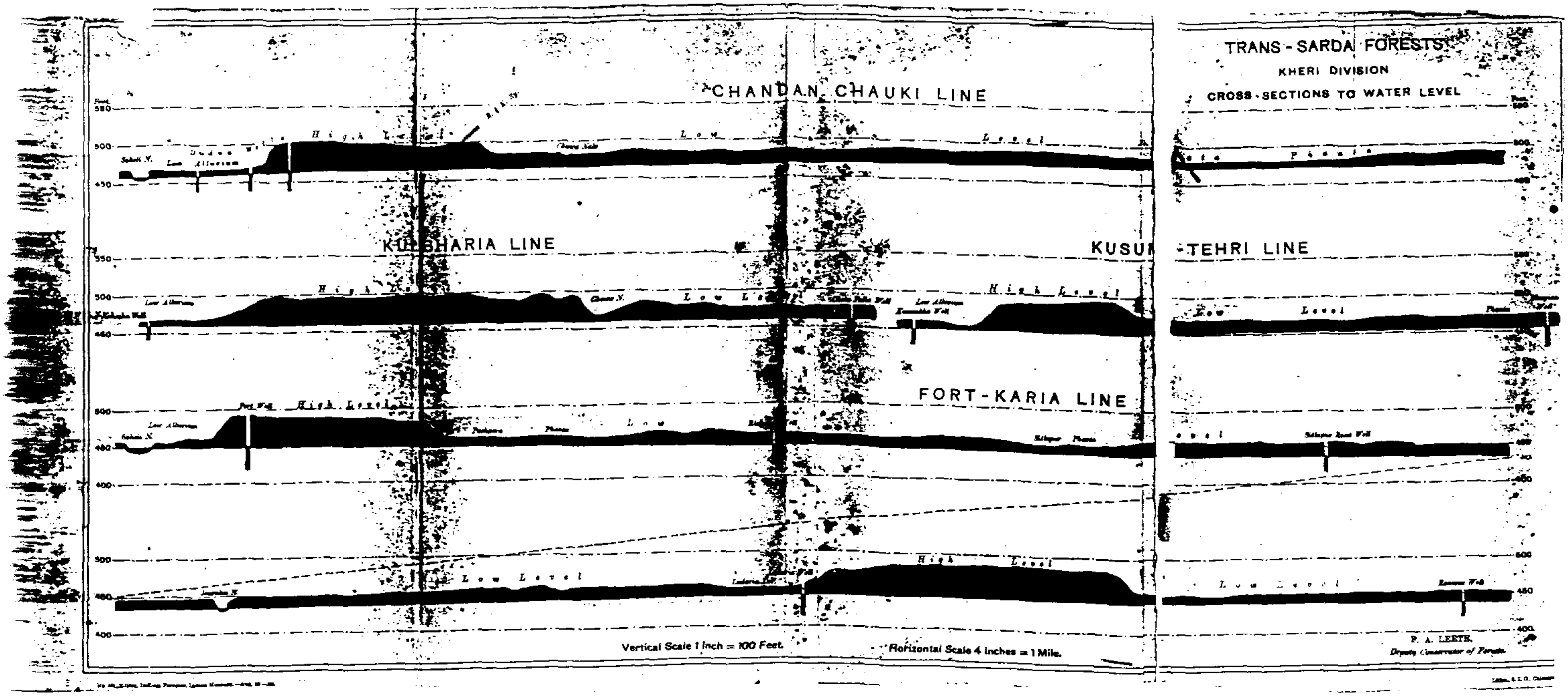
Although in one sense it is true, as "H. J." remarks, that there is very little difference between the two types, yet, as the difference is a real one and not likely to disappear for some generations, if ever, it is worthy of some notice. Moreover, the distinction holds good in the other *sal* forests in Oudh. Based as it is on the configuration of the ground, and corresponding as it does to a difference of some 20 feet or more in the depth of spring water level, there is every reason to suppose that it is of universal application to alluvial formations.

For over three months I wandered about in the Kheri *sal* forests without being able to make head or tail of them. The country was apparently as flat as a table, the soil appeared to be everywhere more or less sandy, and yet the stock showed endless variations between the widest possible extremes.

One day, whilst attempting to work out how far a certain bit of poorly stocked forest extended, I found myself keeping closely to a gentle slope or bank some 20 feet high. The ground seemed to be flat both above and below, and there appeared to be no return slope in sight. The stock, too, seemed to be different in places. Curiosity led me to follow up the slope. I did so that day and the next, still without coming to the end of it. My map and compass had by that time made me realize that I was keeping constantly parallel to the direction of the drainage of the country, and at last it dawned upon me that I was simply following up a natural terrace with the ground on the one side everywhere a little higher than on the other side.

I had started a register of the depth of water in the numerous wells scattered about in the forests when I began field work, but at first it did not appear to be of much use, as the variations were as bewildering as those of the stock above ground. I now, however, set to work to locate the wells with reference to this internal slope. By the time I had done so it was hardly a surprise to find that all the deep wells were on one side of the bank and all the shallow ones on the other side, and that there was no general depth of water anywhere between 20 and 30 feet of the surface.

Better proofs than ocular estimates were necessary, however, to convince the Conservator and the Divisional Officer that the slopes and the differences in levels actually existed. I accordingly amused myself in my spare time with running levels along roads and with making cross-sections. The sections with which this article is illustrated may be taken as typical of the whole, and may be left to speak for themselves.



TRANS - SARDA FORESTS
KHERI DIVISION
CROSS - SECTIONS TO WATER LEVEL
CHANDAN CHAUKI LINE
KUSHARIA LINE
KUSUM -TEHRI LINE
FORT - KARIA LINE
High Level
Low Level
Low Alluvium
Vertical Scale 1 Inch = 100 Feet.
Horizontal Scale 4 Inches = 1 Mile.
F. A. LEETE.
Deputy Conservator of Forests.

(*b*)—STOCK.

Configuration is all very well, but unless it can be shown that there is any connection between it and the state of the tree-growth, its sylvicultural value cannot be very great. With respect to this there are no dissentients. Reference is made to the superiority of certain localities in Mr. Keshavanand's working-plan of 1892. Much farther back than this it was recognized, as a perusal of past correspondence will show. These localities have turned out to be what I have called high level ground.

On the high ground there are practically no blanks; * on the low ground they are only too painfully conspicuous, the whole forest being honeycombed with them. On the high ground, protection has been speedily followed by the appearance of seedlings, rapidly overtopping the scanty growth of grass, and shooting ahead into dense thickets of saplings, wherever they have found an opening in the overhead cover. On the low ground, progress has been much slower. For years after the starting of protection from fires and cattle, in many places it was impossible to find a seedling at all. As late as 1892 ploughing up of the soil and artificial sowing were suggested as a possible necessity, if the backward localities were ever to be improved. Another ten years of protection has shown that this need not be done, but even now there are large areas where the seedlings are in their initial struggle for existence.

A good idea of the state of the forests with respect to the younger classes may be obtained by supposing that they were once very openly stocked, and that, at different intervals, small patches of *sal* reproduction have appeared or are appearing in irregular distribution all over the forests. In some places this occurred so long ago and the patches were so close together that there is now a completely stocked forest in which poles and saplings predominate, as on the high ground. In other places the date of appearance is so recent and the distance apart is so great, that there is nothing more to be seen than a number of isolated patches of advance growth scattered about in a poor and open forest. Between these two extremes there is an infinite gradation which it is impossible to definitely represent on a stock map or in a description of compartments.

Seeing that a study of configuration and water levels has been of so much assistance to a solution of the complex problem in Kheri, it may well be enquired whether these two factors do not play an equally important part in other *sal* forests. So far as I have been able to ascertain, the answer is everywhere in the affirmative. In all the divisions in Oudh terraces are to be found,

* Blanks cover 70 acres on the high ground and 7,337 acres on the low ground (exclusive, in the latter case, of the large grass plains of artificial origin).

marking off the limits of types of growth far more sharply than the insignificance of the slopes themselves would lead one to expect.

The nearer one approaches to the hills, the more the problem becomes complicated. Nevertheless, the finest growth of *sal* is on flat alluvial plateaux or terraces, and undoubtedly the development of the forest following on protection has been far more rapid on these terraces than elsewhere in the hills. This is remarkably true in Garhwal. The *sal*, however, must be very accommodating as regards spring water level. There is nothing to choose, either way, between the vigour of growth of the *sal* on the high ground in Kheri and that on these boulder deposits in Garhwal, and yet in the one case spring water is from 40 to 50 feet below the surface, whilst in the other case it is anything from 100 to 150 feet below ground.

The *sain* (Terminalia tomentosa) is far and away inferior to the *sal* in Kheri, both in distribution and commercial value. Still, it is worthy of notice. "H. J." hardly puts the case strongly enough by stating that the present state of reproduction is poor. There is no recent reproduction at all in the areas under fire-protection. Inside the closed forests I only found one seedling during the whole time I was in Kheri; during the past twelve months I have found the same story to be true in Garhwal. There is a short article on the subject from my pen in the *Forester* for June 1900. In the north-west corner of the Kanjaria Range the reserved forests are separated from Nepal by a 66-feet fire line. On one side of the line there are old *sain* but no seedlings; on the other side there are both.

(c)—EXPLOITABLE SIZE FOR SAL.

"H. J." thinks it rather premature to raise the standard for *sal* from 6′0″ to 6′9″ in the absence of reliable data as to the size to which, under existing conditions, the *sal* will grow without becoming unsound.

If we were to wait for a sufficient number of reliable figures, the question comes in whether the standard would ever be raised at all. I doubt it. Our predecessors made the bulk of their revenue in the timber fellings in the *sal* forests from the big trees of, say, 8 feet girth and upwards. So do we now, to a considerable extent. But in the course of the next 20 or 30 years, with a 6-feet standard, this old stock will have been worked out in all accessible localities, and the next generation of Divisional Officers will have nothing bigger than 7′-6″ to sell. Raising the standard means temporary loss of revenue. Our successors will hardly be prepared to say that we have played fairly if we cut all the big trees and leave them to pay.

The proper procedure undoubtedly is to begin to store up our surplus old stock, *as soon as there are any indications at all that*

our standard is too small. These indications need not be definite, they need not be conclusive. They should be acted upon at once, otherwise the opportunity may pass, never to recur.

Who can say how long a time will be required to exhaust the subject of conclusive data? It is now 23 years since the first sample plots for girth-measurements were started in Kheri, and yet we have very little to go upon with regard to this one detail of the many factors to be taken into account in the determination of the proper size of exploitability.

What special recommendation has the 6-feet standard for the *sal* that we should accept it as final for our time? None whatever. It was a pure guess by our early predecessors On the other hand, have we any *indications* that this standard is too low in the better class of our *sal* timber forests? I cannot answer this question better than by enumerating the reasons which led me to suggest the raising of the standard in Kheri :—

(*i*) Sample plots show that, *of the trees we have had to measure*, the healthier ones have hardly passed their *maximum* rate of growth in girth at 6 feet.

(*ii*) The conical appearance of the crowns of many closely grown and healthy trees of 6 and 7 feet shows that they have not yet reached their *maximum* height-growth.

(*iii*) The trees in class III and upwards, *that we have so far had the opportunity of observing*, had to run the gauntlet of fires and want of protection generally during the earlier stages of their development. It is only reasonable to suppose that trees which have never been touched by fire or tapped for resin may grow faster and keep sound longer than their less fortunate predecessors.

(*iv*) The larger the girth, the less the proportion of waste in conversion.

(*v*) The trees of the future will be much better than those of the present in respect to the length of bole straight and sound enough for use as timber. This extra length will only be used to its full extent if the trees are allowed to stand until the girth at the upper end of the utilizable part of the bole is large enough. As the length of the timber-producing part of the tree increases, so must also the girth at the butt-end.

(*vi*) In the working-plans for the Kumaun, Garhwal and Ganges Divisions, it is recognised that a 6-feet standard is too small for *sal* in the better localities.

(*vii*) It is doubtful whether the demand for revenue will ever permit of a general raising of the standard throughout the United Provinces. This being so, there is all the more reason for making the change in one division at least, now that a favourable opportunity occurs.

(*viii*) Kheri has an excellent system of roads and a railway runs through the middle of the forests, so that the division is one of the most favourably situated ones for the export of large timber. In the hills, many a fine tree has to be cut up into small scantlings because of the difficulty of export; in Kheri carts can be run to the foot of any tree, so that the trade in logs ought to be fostered at the expense of that in sawn timber.

(*d*)—SYLVICULTURAL NOTES.

In the *Forester* for August 1899 there are some notes of mine on the subject of the root-system of the *sal*. The opinion is therein expressed that no hard-and-fast line can be drawn between seedling and coppice growth. Theoretically, it may be more correct to say that the reproduction in the Kheri forests is from coppice shoots, but, for practical purposes, it is better to treat of it as reproduction from seed. It is the nearest approach to growth from seedlings that there is ever likely to be in nature. Until the root-system has been developed, growth above ground is out of the question for the *sal*.* This may as well be admitted and, at the same time, as the *sal* is such an important tree, we have cause to be thankful that the seedling is so accommodating that it will exist for a considerable number of years in dense shade patiently waiting until the opening out of the overhead cover gives it the chance to shoot ahead. In fact, it is chiefly owing to this characteristic that the holes caused by fellings so quickly fill up, and that the *sal* not only grows gregariously but that it does not give much chance to other competing species.

"H. J.'s" concluding remark, that any working-plan which ignores this habit of the *sal* of continually dying back is thereby likely to be upset, is hardly correct. Under any system of working depending on natural reproduction, the initial stages of the struggle for existence on the part of the seedlings which will form the crop of the future in any coupe, will have been passed when the fellings begin. The splendid young stuff that shows up within a year or two after a hole in the overhead cover has been made, by the removal of a big tree or two, does not as a rule originate from seed that dropped after the felling; more often than not it is from seedlings which began life some years earlier.

For example, Compartments 20 and 26, on the high level ground near Dudua, were heavily felled over in 1890-91: $3\frac{1}{2}$ I class *sal* trees per acre were taken out of the former, and $2\frac{1}{2}$ per acre out of the latter. The stumps of these trees are now

* *Vide* the series of articles by Mr. Eardley-Wilmot, printed in the Appendix to the *Forester* for 1899.

hidden away in dense thickets of saplings, many of which are as much as 9″ to 12″ in girth. Obviously very few of these could have been more than small plants a foot or two high when the fellings took place, and so one's first idea would be to say that the saplings are now only 13 years old; but it would probably be much more correct to add "H. J.'s" 20 years and put it at 33 years. All the same, 13 years would be much the more important figure for a working-plan.

Although the foregoing example is taken from a bit of extra good forest, the argument also applies to poor localities, provided that the fellings are based on sylvicultural rules suitable to the *sal*. On the low level ground there are many backward places where the stock consists merely of an open crop of old *sal* trees standing in heavy grass. Such trees should on no account be removed until a few seedlings at least are visible in the grass round about. By the time that a few have raised themselves above the grass, the chances are that there will be plenty more *in* the grass. The rate of growth after the removal of the big trees may not be as fast as in Compartments 20 and 26, but it should not be necessary for the Working-Plan Officer to make an allowance of more than 4 or 5 years over and above the interval since the felling.

The first sign of improvement in a bad *sal* forest is generally the appearance of miscellaneous undergrowth, chiefly composed of 'rohni' (*Mallotus philippinensis*). The cutting back of this shrub-growth should be regulated by a rule similar to that applying to the felling of mature *sal* trees. If the shrubs are so thick that all grass is killed off, the chances are that they will also prevent the appearance of *sal* seedlings; but, here and there, openings in such bush cover are sure to be found, and it may be taken as a standing rule that the time to cut back the undergrowth will not be until young *sal* have begun to appear in such openings.

In the Trans-Sarda Working-Plan it is assumed that the V class period is 35 years. All that this means is, that we are tolerably certain that, within 35 years of the felling of any mature tree that ought to be felled, the place of that tree will be taken by saplings and poles, of which a sufficiency will be fully 18″ in girth. Nothing is said about the age of such saplings and poles. As "H. J." remarks, this has still to be even approximately determined.

In calculations of the "possibility," the V and IV class periods may be left out of account at present for all practical purposes. We know neither the normal class proportions nor the average percentages that pass from class to class. The lower we go down the scale the more we have to resort to mere guess-work.

Root-Parasitism of the Sandal Tree.

DURING my visit to the Salem Javadis (hills) in January last, I observed a sandal seedling, about half an inch in diameter, growing on a slope close to a clump of *Webera asiatica*. On digging along one of its roots, I came on one of the rootlets attached to a root of the Webera. At the point of attachment a white tubercle about $\frac{1}{8}$ inch in diameter had been formed on the host and the sandal rootlet penetrated the tissue of the host through the tubercle. I secured the specimen but it was subsequently lost.

I visited the hills again in the latter part of February last with the special object of inspecting the sandal tracts on the plateau. During my inspection, I noticed some young sandal seedlings under a parent tree which was growing on a slope about a yard away from a flat rock. The young seedlings were growing on a thin layer of loose soil, mixed with humus, on the rock and at its foot. I dug up two of the seedlings which were growing isolated and found no traces of root-parasitism. They were about six months old, with a good number of root-fibres and root-hairs. They are drawn to full size and marked B and C on the accompanying Plate No. I. About a yard away from these plants I found similar seedlings surrounded by a growth of Strobilanthes. I dug up these seedlings carefully and found their roots attached to a network of the roots of the Strobilanthes, which I afterwards ascertained with the aid of Hooker's *Flora* to be *Strobilanthes cuspidatus*. Plate No. I-A is a full-sized * drawing of one of these seedlings and illustrates the root-parasitism of the sandal even at the early age of six months.

Plate No. II shows another sandal seedling a trifle older. The attachment of its rootlets to the roots of the Strobilanthes is quite distinct at the points a a a. The leaves of the Strobilanthes are shown in the drawing smaller than their natural size, the sketch being taken from a dried specimen.

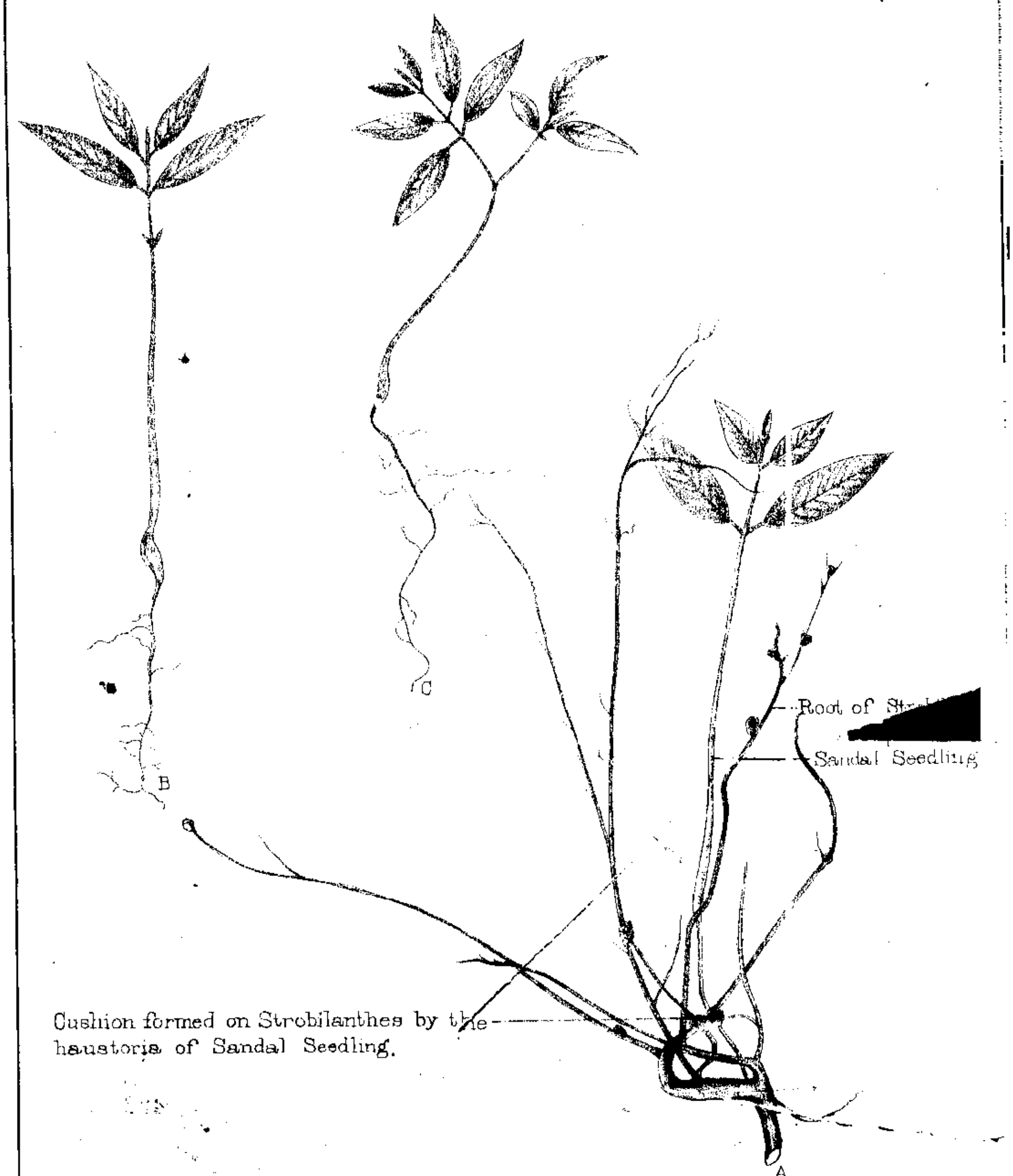
On the edge of the rock I found a much larger seedling, probably about three years old. This I also dug up, and at a point on the lower portion of its tap-root it was found attached to a thicker root of the Strobilanthes. While digging the tap-root snapped off, so its full length could not be secured.

Plate No. III is a drawing of this seedling and shows the attachment of the tap-root to the root of the Strobilanthes.

In all the above instances the tubercles, or cushions* as Mr. Barber calls them, formed at the points of attachment, were of a

* In order to reproduce the plates for insertion in the magazine they have been reduced. The originals, which are coloured, are being sent Home to Sir Dietrich Brandis.—HON. ED.

PLATE SHOWING ROOT PARASITISM OF A YOUNG SANDAL SEEDLING ON THE ROOT OF STROBILANTHES CUSPIDATUS

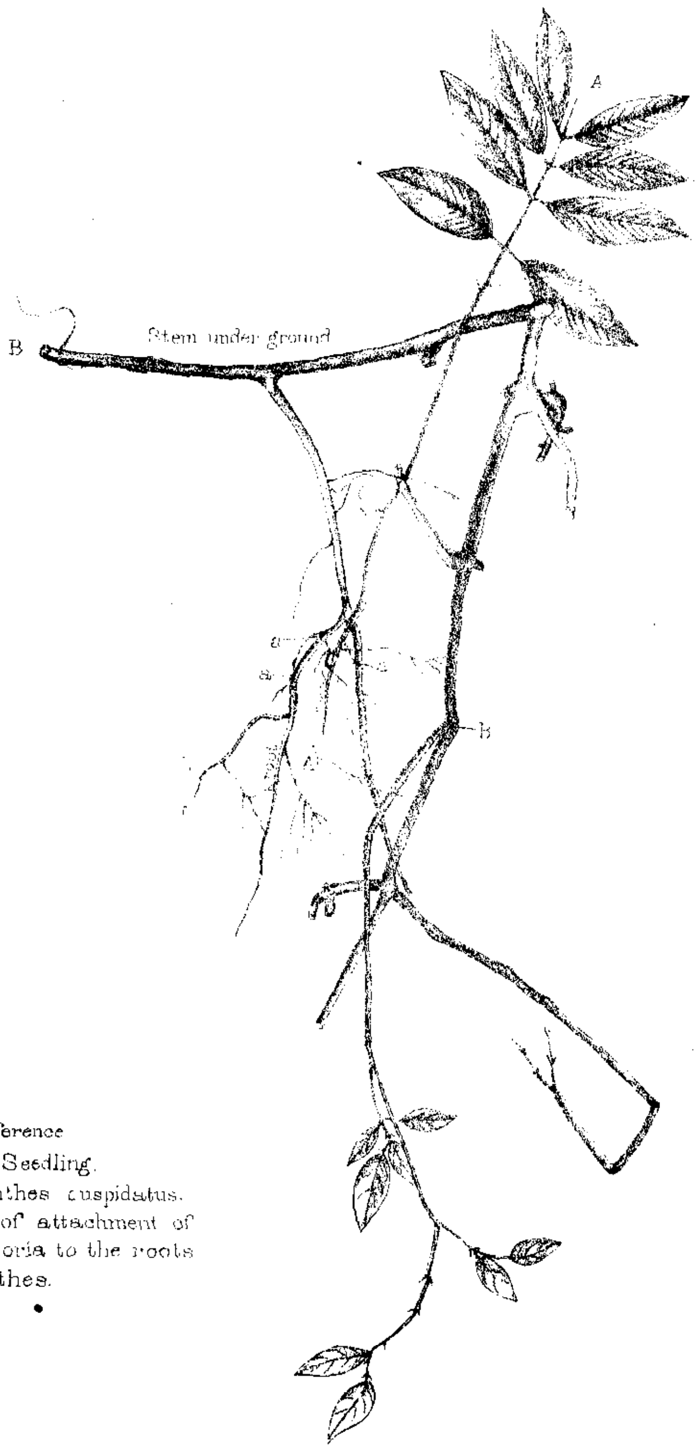


Reference

A Sandal Seedling with its root attached to root of Strobilanthes cuspidatus.
B. and C. Sandal Seedlings without attachment to roots of any other plant but showing small root fibres and root hairs.

Lith. by A C Chowdhary

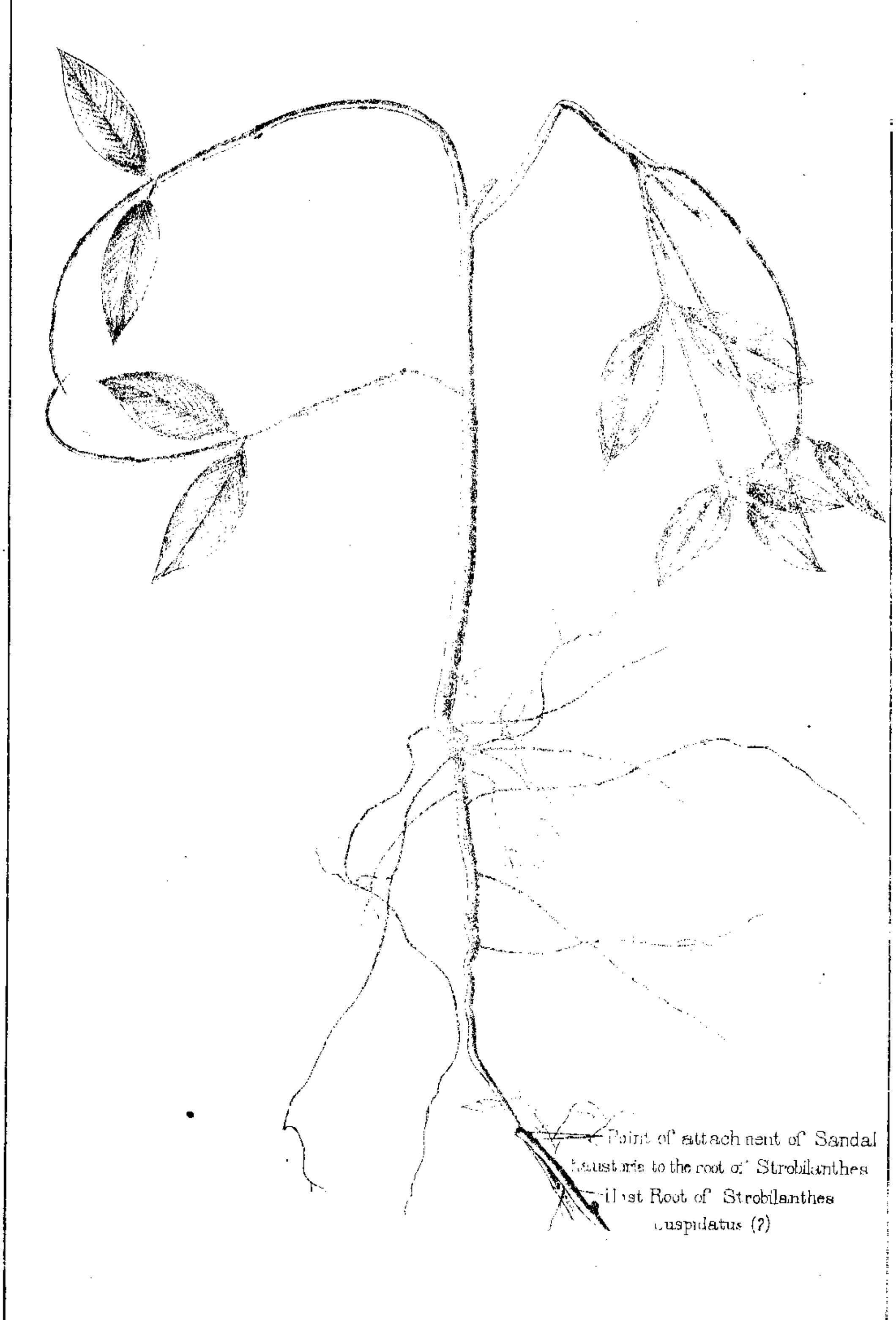
PLATE SHOWING ATTACHMNT OF THE ROOTS OF A SANDAL SEEDLING TO THE ROOTS OF STROBILANTHES CUSPIDATUS (?)



Reference
A.A. Sandal Seedling.
B.B. Strobilanthes cuspidatus.
a.a.a. Points of attachment of Sandal haustoria to the roots of Strobilanthes.

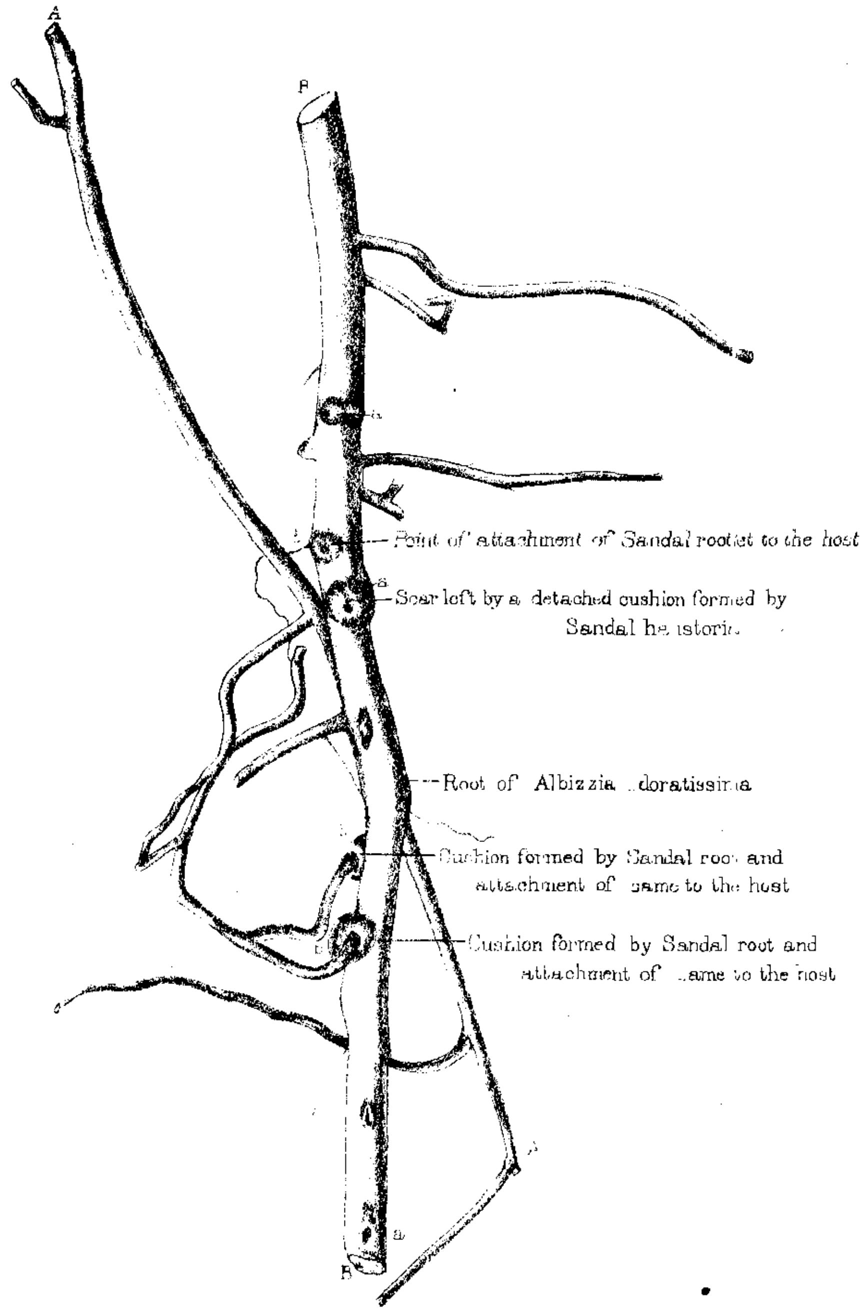
Del: E. Ebenezar Pillai. Lith: by B. C. Mondul.

PLATE SHOWING ATTACHMENT OF SANDAL ROOTLET TO A ROOT OF STROBILANTHES CUSPIDATUS



Del: E. Ebenezar Pillai. Lith: by A. C. Chowdhary.

PLATE SHOWING ROOT PARASITISM OF SANDAL ON A ROOT OF ALBIZZIA ODORATISSIMA



Reference

a.a.a. Scars of fallen off cushions formed by Sandal haustoria
b.b.b. Points of attachment of Sandal rootlets to the host (Albizzia odoratissima)

A.A. Root of Sandal
B.B. Root of Albizzia odoratissima

Del: E. Ebenezar Pillai. Lith: by A. C. Chowdhary.

dull white colour and more or less round or spherical in shape. They varied in size from about one-tenth to one-eighth inch in diameter.

In the course of digging up the above seedlings, I came upon a sandal root exposed on the surface of the ground about 20 feet from the parent tree, and noticed a tuft of suckers on the exposed portion. This root trailed down the slope and it was therefore easy to examine it. I dug along this root to see whether it had attached itself to those of other species. It was about three-fourths of an inch in diameter at the exposed portion. As the digging proceeded I noticed small rootlets branching off, and following up one of them I found that, at a distance of 25 feet from the parent tree, it branched off into still smaller ones of which the ends were attached to the roots of an *Albizzia odoratissima*. At the points of attachment the cushions formed were large, ellipsoidal in shape and of a dark-red colour. They were more or less hard, woody and brittle when dry. Plate No. IV shows a drawing of one of the specimens I secured. In this plate, A A is the sandal root, B B the root of the *Albizzia*; a a are scars of fallen off cushions and b b b are points at which the sandal roots were attached to the host when the specimen was dug up. Plate No. V represents a couple of roots of *Albizzia odoratissima* which are covered with the scars of cushions formed by the sandal haustoria. The scars are of different shapes, varying from a circular to an elliptical figure. The central part of the scars is depressed, with an elevated outline right round: sometimes the scars present the appearance of magnified stomata with a central slit, the depressions taking the place of guard-cells. These roots were obtained while extracting the specimen drawn in Plate No. IV and formed the roots of the plant therein figured.

I had some stems of the Strobilanthes dug up by the roots about 15 feet away from the sandal tree and found these roots were full of tubercles. Suspecting that these latter might be naturally formed on the roots independently of the action of the sandal haustoria, I proceeded up the slope and pulled up some more Strobilanthes stems without finding a single tubercle on their roots. There being no sandal tree within 200 yards of these bushes, I concluded that this species did not naturally form tubercles on its roots, and that the presence of such tubercles on its roots lower down the slope was due entirely to the parasitic action of the sandal or other (?) roots.

While on this subject, I might attempt an answer to the two important questions suggested by Sir Dietrich Brandis in his note on the "Treatment of the Sandal Trees" in the January number of the *Indian Forester*. The first question suggested is—"Has the tree effective root-hairs, and is it capable of taking up directly from the soil a portion of the food it requires?" My answer to this

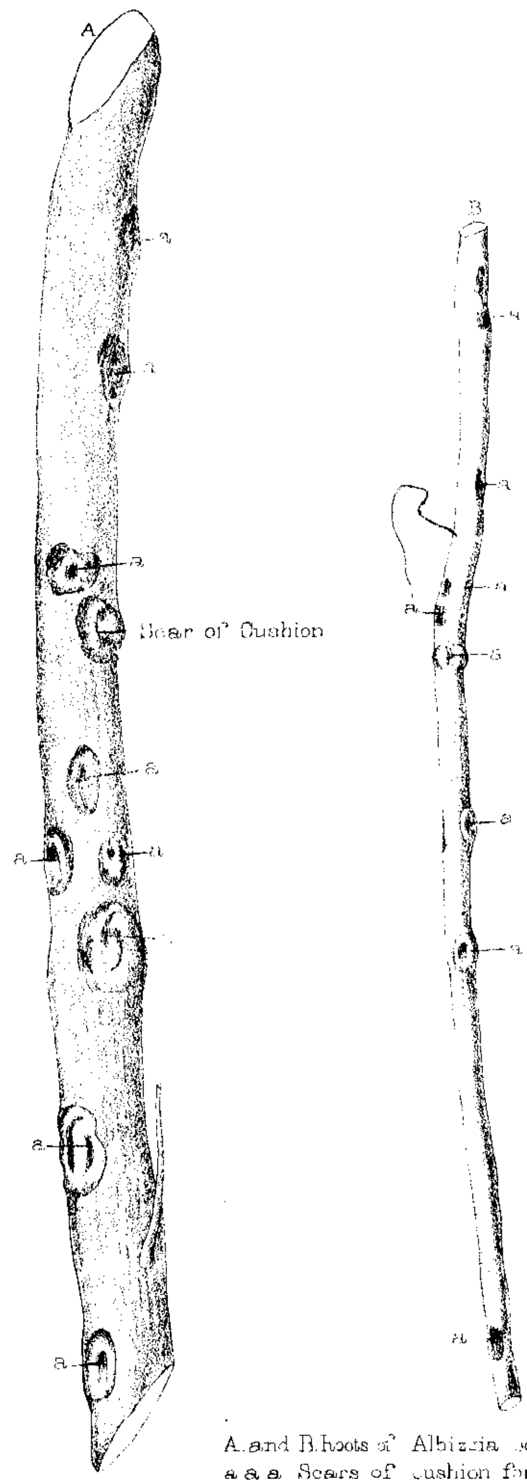
question must be a partial one and confined to seedlings, as my observations so far are limited to the root-system of seedlings. In seedlings there is a fair development ot root-hairs and root-fibres, which in some instances are numerous and dense. I have found minute particles of the soil sticking to these root-hairs and it required some amount of force to separate them. But in the case of seedlings which have already formed root-union with other species, root-fibres and root-hairs are comparatively scanty. As regards the presence of root-hairs and root-fibres in grown-up sandal trees, my observations were hitherto confined to the roots of trees growing amidst other species, with the roots of which the sandal roots had formed connections. In such sandal rootlets and root-ends I found no root-hairs but only a few root-fibres or thin thread-like rootlets. As this is an interesting study, I shall devote special attention to this point as opportunities offer, and the results will be communicated to the *Indian Forester*.

The second question suggested is—"Which species are the most useful companions of the sandal wood?" The sandal is associated with the following species on the Javadi plateau :—

(1) Albizzia odoratissima.* (2) Albizzia amara. (3) Litsæa zeylanica. (4) Litsæa tomentosa.* (5) Terminalia paniculata.* (6) Terminalia Chebula. (7) Terminalia belerica. (8) Terminalia ovalifolia.* (9) Anogeissus latifolia.* (10) Premna tomentosa. (11) Zizyphus Œnoplia.* (12) Zizyphus xylopyra. (13) Scutia indica.* (14) Randia dumetorum. (15) Randia uliginosa. (15) Webera asiatica.* (17) Acacia coesia.* (18) Acacia pennata.* (19) Pterolobium indicum. (20) Pongamia glabra.* (21) Memecylon edule.* (22) Strobilanthes cuspidatus.* (23) Olea dioica.* (24) Flacourtia sepiaria.* (25) 2 shrubs of the Anonaceæ, probably species of—(26) Polyalthia, known among the hillmen as *Palicha** *Sedi* and *Kakanan** *Sedi*. (27) A tree, probably of the Myrtaceæ,* called *Porumbulu* by the hillmen. (28) Grewia asiatica (?). (29) Atalantia monophylla.* (30) Limonia acidissima. (31) Murraya exotica.* (32) Prosopis spicigera. (33) Acacia Sundra. (34) Bambusa arundinacea.* (35) Dendrocalamus strictus.* (36) Toddalia aculeata.* (37) Mallotus philippinensis.* (38) Morinda citrifolia. (39 Albizzia Lebbek. (40) Cassia auriculata.

Of the above species those marked with an * are found more frequently associated with the sandal than the others, and it is in the company of some of them that the finest and largest sandal trees are found on the Salem Javadis, notably at Kambugudi, Tagarakuppam, Chembarai, Puliyur, Nellivasal and Nellipattu villages. My own observations have established beyond doubt the root connection of the sandal tree with the roots of Nos. 1, 16 and 22. Further observation will doubtless reveal the exact relationship of the other species with the sandal, with reference to the latter's growth and development.

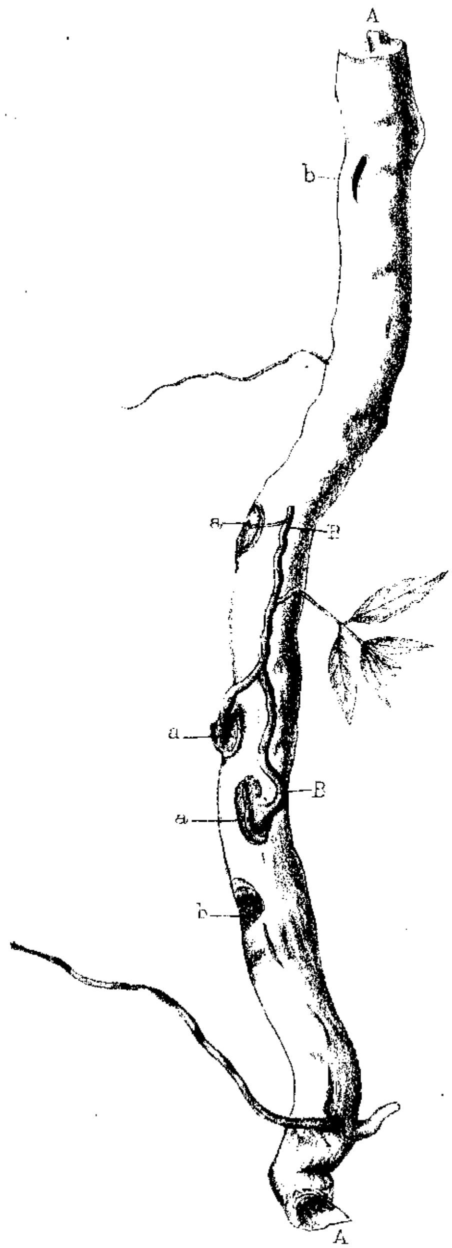
PLATE SHOWING ROOTS OF ALBIZZIA ODORATISSIMA SHOWING SCARS OF FALLEN OFF CUSHIONS FORMED BY SANDAL HAUSTORIA



A. and B. Roots of Albizzia odoratissima.
a a a. Scars of cushion formed by the haustoria of Sandal roots.

Del. E. Ebenezar Pillai. Lith. by S. C. Mondul.

PLATE ILLUSTRATING ROOT ATTACHMENT OF SANDAL TO THE ROOT OF LIMONIA ACIDISSIMA



Reference
A. A. Root of Limonia acidissima.
B. B. Sandal root.
a. a. a. Points of attachment of Sandal rootlets to the host.
b. b. Scars showing past attachment.

Del: E. Ebenezar Pillai. Lith: by S. C. Mondul.

I have found self-sown sandal seedlings growing in aloe hedges at Timpatur with *Morinda citrifolia* and *Melia indica* (nim). In the hedges of gardens at Salem it is found growing along with *Inga dulcis*, *Morinda citrifolia*, *Feronia elephantum*, *Alangium Lamarckii*, *Cocos nucifera*, *Mangifera indica*, *Psidium guava*, and *Moringa pterigosperma*.

The above answers to the questions raised by Sir D. Brandis are by no means full and satisfactory. I hope to furnish at some future date more information on these points after further observation and study.

Since writing the above note I have had opportunities of investigating this subject further.

While camping at Pennagaram on the 17th May last. I noticed some sandal trees growing in a forest tope, and selected for examination a sapling about 2½ inches in diameter growing in the fence of the tope, and at a distance of about two yards from it was a large *Albizzia Lebbek* and a tamarind tree. I dug along a root of the sandal and found it crossing a number of small tamarind roots, none of which were affected by the roots of the former. Further on I came on a small root of the Albizzia and found it covered with depressions exactly like those found on the roots of *Albizzia odoratissima* figured in Plate V, and I have no doubt that these depressions were the scars of the fallen off tubercles or cushions formed by the sandal "haustoria." The affected root of the Albizzia showed signs of exhaustion and approaching death. In this investigation I found no actual attachment of the sandal roots to the roots of the Albizzia or tamarind. The sandal sapling itself was stunted and unhealthy with a meagre crown and many dead twigs. Its root-ends were not vigorous and some were dead or dying.

On the 24th May I walked up the Shevaroys from the hill-foot along the old ghat road in the company of the Acting District Forest Officers of North Arcot and Chingleput. Where the road entered the sandal zone I carefully observed the cut side of the hill slope in hopes of finding some sandal roots, and came upon an exposed root of a white-brown colour, with a small dark-coloured root attached to it and bearing a small leafy shoot which, on examination, was found to be a sandal root-sucker. I then traced the larger root (host) to its source and found it to belong to a *Limonia acidissima* tree growing on the top of the cutting.

The sandal root was attached to the host at three points, at each of which a tubercle had formed. This specimen was shown to all the District Forest Officers, as well as to the Conservator of the Central Circle, who had assembled at Yercaud for a Forest Conference. The accompanying plate, Plate VI, is a correct and full-size drawing of the specimen and proves unmistakably the root parasitism of the sandal on the roots of *Limonia acidissima.*

Forestry in America.

By H. J.

(*Continued from page* 334.)

Chapter V.

Chapter V of Dr. Fernow's book, *Economics of Forestry*, is devoted to the factors of forest production, and business aspects.

Forestry differs from agriculture, and all other productive industries, principally in the time element; agricultural crops are harvested annually, or at most require only a few years for their production, but wood crops are only useful after many years' growth has been accumulated, and most timber-producing species require between 100 and 200 years to yield timber of the most useful size.

The quality of the wood, too, improves, within limits, with its growth in size, and the proportion of the timber of the bole begins to preponderate over the branch wood of the crown.

The rate of growth varies with the different species and with the soil, climate, surrounding conditions, and with the age of the tree.

Some soft light-wooded trees grow very rapidly up to forty years of age, and then soon cease to grow, and die; while the best timber-producing species, and the conifers, grow slowly at first, then faster, and continue growing at a more or less uniform rate till old age.

The study of the quantitative production of crops of different species, and of different ages — the mathematics of forest growth,— is of great importance. The determination of the exploitable age depends not only on the species, soil and climate, but also upon market conditions, industrial requirements, and economical considerations.

Beside the time element, there are three other factors of production, namely, nature, labour and capital.

In agriculture, labour is the most important, nature second, and capital last; while in forestry, nature comes first, then capital, and labour is the least important.

The labour required in forest work is, moreover, very simple, and involves but little technical skill. In Germany there is one guard to about every 1,000 acres, and in India, where the cost of the largest permanent forest establishment in the world amounts to about one quarter of the gross revenue of the forests,

the total number of permanent employés of all ranks from the Inspector-General downwards, is about 10,500, or one to about 7,500 acres of forest.

It is evident that the use of both of the elements of nature and of labour differs widely in forestry and in agriculture, and that forestry can only be profitably practised over comparatively large areas.

The factors of soil and climate, too, have a different significance; agriculture deals mainly with vegetable products which originally came from different climates to those in which they are now grown, but have been adapted to their present conditions, and have been improved by man for his own use. A wood crop on the other hand is generally just as nature, unaided, produced it during a long cycle of development, and the forester's influence does not extend beyond increasing the production of material of useful form and of useful species per acre.

But the greatest difference between the two industries, and one of the highest national economic importance, is the difference in the use of the soil.

Agriculture is engaged in obtaining food materials whose production relies largely on the mineral wealth of the soil, especially the phosphorus, sulphur, potash and nitrogen. Unless these are replaced by manures, or through a rotation of crops, the soil becomes exhausted and unfertile.

On the other hand, forestry is mainly engaged in the production of cellulose, which contains a minimum of these rarer elements.

The air supplies one half the constituents, namely, the carbon, and almost the other half is furnished by the water of the soil, while the wood, the final product, only contains about one per cent. of mineral ash.

The parts of the tree richest in minerals—the fruit, the flowers, the leaves, twigs and branches—fall to the ground, and not only return to the soil the fertility derived from it, but enrich its surface by the decay of the litter, through the vegetable humus and the nitrogen-condensing bacteria formed in the same.

Thus, while agriculture exhausts soils, forestry enriches them.

From the soil the forest crop derives mainly the water required for its biological processes, including the transpiration of its leaves and for the composition of its wood, and lastly the hygroscopic water which is finally lost when the wood seasons. Chemically, water forms 48 per cent. of the wood substance, while 50 per cent. more is hygroscopically bound to it in the living

tree, ten or twelve per cent. remaining so in the wood after seasoning. The 8,000 pounds annual product on a fully-stocked acre thus divides itself up into 3,000 pounds dry substance, 1,250 pounds of water chemically bound, and 3,750 pounds of hygroscopic water. Forest crops can thus be grown on soils too poor for agriculture, and no manuring is required, provided the litter is left.

Soils and situations topographically unfit for agriculture may also be usefully employed for forest growth. Mountain slopes too steep for plough land, and even for pasture, are still suitable for forests, and it is precisely such places where, for the protection of the ground and for favourable water and climate conditions, a forest cover is most needed.

The annual production per acre, including the brushwood, may rise under favourable conditions to as much as 100 cubic feet; but for timber-producing forests, the average annual yield in large forest administrations, including everything down to 3-inch diameter, may be about 50 or 55 cubic feet.

The third factor of production, *capital*, must be divided between the fixed investment laid out as a basis for continuous production, and the current working fund required to carry on the business. The latter may often in any forest business be very small, as little is required usually in the way of machinery, buildings, tools, seeds, etc., but the amount and character of the permanent capital renders the regulated forest business unique. Both farming and forests have in common the soil as the basis of production, but in forestry the greater part of the fixed capital is represented not so much by the soil, but by the accumulated growing stock of wood, since the wood accretions of many years are tied up, as it were, as a fixed capital, accumulating with compound interest, until the exploitable age is reached.

Suppose, for instance, a forest which is best harvested at a hundred years of age; then, in order to fell every year a crop of one-hundred-year-old timber, we require a series of 100 crops, each one differing in age by one year, from 100 years down to yearling growth.

The contents of the 99 crops expressed in volume or in value are the wood-capital, and the hundredth crop is the interest or yield.

The capital stock of wood, which must be maintained, is evidently about equal to the increment occurring over the whole forest through half the rotation.

It is also obvious that in coppices worked under a short rotation, the wood capital is much smaller than in a timber forest worked on a long rotation.

As an instance, taking 70 cubic feet of wood per acre as the average annual production, then a coppice of 100 acres under a 20 years rotation would require as wood-capital 70,000 cubic feet, while the same area worked for timber with a rotation of 120 years, would require a wood-capital of 420,000 cubic feet, or six times as much as the coppice in volume, and many more times in value, since timber is much higher priced than fuel.

In actual practice the disproportion is generally even greater, and the wood-capital in the timber forest is often 10 or 20 times as large as in the coppice.

Finally, in a properly regulated forest worked for large timber, the soil and wood-capital combined will be between two and ten times the capital required in agriculture.

From what has been said above, two most important deductions from the standpoint of political economy follow :—

First, the time element, together with the large capital required to produce timber, renders forestry an undesirable business for private owners of limited means; only the State and, in a less degree, other permanent corporate bodies, can profitably engage in it.

Secondly, the fact that capital and interest are identical in nature and are mixed together, only to be distinguished by voluntary economic considerations and self-imposed saving, results in the fact that the systematic management for continuity may very easily be unbalanced by liquidating a part of the capital without immediately appreciable loss, and that consequently only the State and other communities who have an interest in continuity can safely (apart from considerations connected with the large capital required) be entrusted with the forestry business.

The dangers to the wood-capital from fires, storms and insects can always be reduced to a minimum of permanent injury, especially if the property under one management is large, and though the rate of interest, 3 or 4 per cent., derived from forests, is small, yet the safety of the investment is great, and it is certain that the price of wood must rise in the future, since the forest area rather tends to diminish, while the demand for wood increases.

Chapter VI.—Natural History of the Forest.

The forester has to do with forest crops rather than with single trees, and he has the power, within limits, of influencing the composition of the natural forest, which is the result of an evolutionary struggle among the different forms of vegetation,

into a form suitable for his purposes. The limits are set by the adaptability of the species to soil and climate, and by the forester's skill in recognizing and utilizing the laws under which the natural forest develops.

Temperature and moisture determine in the first place the natural distribution of the various species. A succession of different types of forest, and different species, are met with as we pass from the tropics to the northern latitudes; and similar zones of forest growth are also met in ascending from sea-level in tropical or sub-tropical regions up to the highest altitudes, where forest growth is found. The relative humidity, too, brings about changes in forest types, from the damp swamps near the seashore up to the dry and rainless interior of continents. Dryness, like cold, diminishes growth and reduces the number of species composing the forest.

Soil conditions, too, within the geographical range of the species thus limited, differentiate the distribution.

The frugal pines will subsist on the poorest, barest soils, other species prefer wet situations; a few will only thrive on rich loamy soils, while others will adapt themselves to almost any soil conditions. The absence of a species from any locality does not however necessarily mean that it cannot exist there, as there are mechanical barriers, such as wide oceans and high mountain ranges, or there may be absence of means of transportation for the seed. All such difficulties man can overcome, and in forestry acclimatization, so called, is practically confined to overcoming such mechanical barriers.

As a rule the forester relies on the species which he finds naturally growing in the locality, and he can do little to improve on the quality of the wood as nature produces it.

While the presence of a species in the composition of the natural forest is in the first place due to climate and soil conditions, its numerical distribution and the manner of its occurrence in the mixed forest depend primarily on two qualities in combination, namely, its relative rapidity and persistence in height-growth, and its relative requirements for ligut.

The character of the seed and the manner of seed-production and seed-transportation are additional factors.

Some species bear seed prolifically every year, while others only produce seed at intervals of several years Some seeds are heavy and large, such as the walnut and acorn, and cannot travel unless squirrels, mice or birds carry them; while others, like the light-winged seeds of the birch and poplar, are easily carried by the winds, and so become ubiquitous. Some seeds, such as

those of the willow, lose their power of generation within a few days, while others of the leguminous tribe preserve their seeds alive for many years.

After the peculiarities of the seed comes the peculiarity of growth. One species will grow very slowly during the first few years of its life, but will then be forming a stout root-system, which afterwards may give it a great advantage over a quicker-growing rival. A fast-growing species like the poplar may cover large areas, but its reign is short, and the slower-growing shade-bearing spruce will eventually by its persistency occupy the ground.

Capacity to resist frost, drought, fire, insect attacks, and other causes of injury will also affect the distribution of the different species, but finally the two qualities first mentioned, relative height growth and relative light requirement, are determinative.

Just as in a mixed forest the species are distributed according to their shade-endurance, so in a pure forest of one species, the individual trees of different sizes develop side by side according to available light, each crowding the other, until the laggards are killed by the withdrawal of light.

As an example, in a fully stocked acre of American white pine (a species analogous to the spruce) there may at first be 50,000 or more seedlings in a dense thicket, excluding all light from the soil. After a few years the lower branches, shut out from the light, die and fall off; this natural cleaning of the bole takes place during the period of rapid height-growth, between the tenth and thirtieth years. At 30 years old the trees are slender poles of about 4 inches diameter and 20 to 25 feet in height; but different degrees of vigour of development, according to individual constitution and accidental opportunity, can now be recognized, and three classes may be differentiated: the predominant, with their crowns 5 to 10 feet above the general level, which are the trees of the future; the sub-dominant, ready to occupy the air-space of any of the superior class should accident remove any of them; and lastly, the suppressed ones, doomed to die.

Out of the tens of thousands which started, only 2,000 or 3,000 survive, and as each tree is striving with its neighbours for as much air-space and root-space as possible, the result is a continued diminution of the number of trees occupying the acre.

This decimation is in exact mathematical relation, barring accidents, with the development of the dominant class in height-growth.

At the age of 80, not more than 400 to 500 trees are left. After this age the diminution proceeds more slowly, until at

last only 200 or 300 stems occupy the ground, the number varying with species, soil, and climate.

The height-growth is now practically finished, and the branches will no longer lengthen to occupy the air-space. No numerical change will therefore take place, except as the result of accidents, until the crop passes its age of maturity.

This factor of light is not only the most important one in bringing about the evolution of the natural forest, but it is practically the only one under the control of man. With the knowledge of the light requirements, and with the judicious use of the axe, the forester can suppress one species and stimulate another, can direct in quantitative and qualitative development the progress of his crop, and finally secure a regeneration in the most useful species.

Not only is the composition of the forest largely a result of changes in light conditions, but the actual amount of production is a function of the light, for the annual production of wood is in direct relation with the amount of foliage which the tree can exhibit to the influence of light.

The whole art of forestry is based upon the laws of accretion.

It is in the pole stage that the maximum rate of height-growth occurs, generally between the ten and fifteenth year with light-demanding, and between the twentieth and fortieth years with shade-bearing species.

The diameter growth proceeds slowly until a fully formed crown and root-system can elaborate the necessary material, and generally reaches a maximum between the fortieth and eightieth year, then very evenly declining into late life; the sectional area, however, will continue to increase some time after the diameter rate has begun to sink, as each year's deposit is made on a larger periphery.

The form of the bole, too, is of great economic interest. With trees growing in the open, with large crowns and low branches, *so much food is elaborated that the lower portions receive an* excess, and the trunk will taper rapidly upwards from a broad base, while trees grown in a dense forest crop will have small confined crowns, and long clean boles, which will be almost cylindrical in shape.

The mean annual increment of any individual tree growing in full enjoyment of light goes on increasing up till old age.

In the United States a good beginning has been made to follow German Foresters in trying to determine the volume development of crops; for this, both height and diameter, and

volume growth of the various size-classes, together with the gradual diminution in numbers which takes place in a fully stocked crop, must be studied.

These measurements show that the same acre always produces annually the same *weight* of dry wood, with practically whatever species it may be grown, namely, from 4,000 to 8,000 pounds per acre, according to the quality of the ground. The volume may vary according to the specific gravity of the wood of different species, and according to the water contents. About three-eighths of this product is useful wood material, nearly one-half being roots and foliage, and nearly one-quarter brushwood and bark. The annual production of *available* dry wood substance above ground varies, according to the quality of the climate and soil ("site"), from 3,500 pounds on good sites to 1,200 pounds on the poorest. The number of trees to the acre is of no consequence, provided that a full crown cover is always kept.

The important factor in production is therefore the intensity of utilization of the light, and not the number of trees; the proper gauging of numbers is, however, one of the most important operations of the forester, because the question of numbers of trees affects the distribution of volume in more or less useful form.

We have already seen that in a dense young growth of nature's sowing there may be 50,000 or more trees per acre, which, by natural thinning after the twentieth year, are reduced to 2,000 or 2,500, and then diminish steadily at a slower rate, until, at the end of the hundredth year, only 200 to 250 occupy the upper crown level, or only 10 per cent. are left. Thus, while the mean annual increment has been increasing, there has been a constant loss by the death of the inferior trees, a loss in volume equal to 35 or 40 per cent. of the final harvest, and which can, in part at least, be saved by timely interference and realization.

As standards of measurement of the rate of production of timber, yield tables have been compiled for fully stocked crops of each species and for five site-classes: the contents of the dominant growth are given in ten-year periods, and represent the attainable maxima.

The following two tables will serve as an illustration. Only timber, that is, wood of over 3-inch diameter, is stated; and the volume of the thinnings, which may be about 30 per cent. if the final harvest is omitted.

Both tables refer to first class sites, and show the difference between the production of the shade-bearing fir and that of the light-loving pine.

"Site" means soil and climate conditions or "quality of the locality."

YIELD TABLE OF FIR. SITE-CLASS I.

Age.	Number of trees.	Average height in feet.	Volume, cubic feet.	Volume increment. Mean	Current.	Per cent.
20	5,300	17	990	50	197	26·1
30	2,210	31	3,550	118	317	8·4
40	1,220	43	6,530	163	224	3·2
50	750	50	8,615	172	172	1·9
60	540	65	10,280	171	144	1·4
70	410	73	11,675	167	125	1·0
80	325	81	12,890	161	110	·8
90	270	88	13,950	155	96	·7
100	230	95	14,890	149	86	·6

YIELD TABLE OF SCOTCH PINE. SITE-CLASS I.

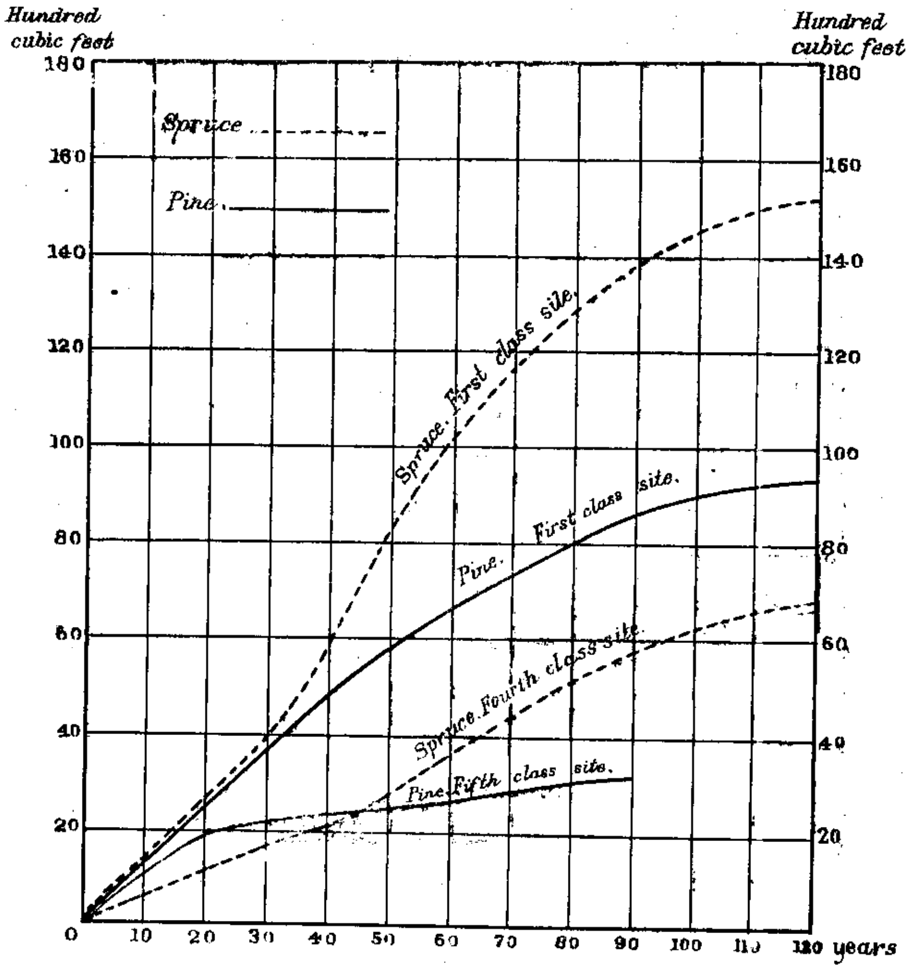
20	1,700	23	775	39	98	13·0
30	1,170	36	2,185	73	138	6·0
40	726	50	3,820	95	113	3·0
50	510	63	5,000	100	94	1·9
60	380	72	5,935	99	80	1·3
70	300	80	6,700	96	66	1·0
80	245	86	7,330	91	58	·8
90	200	92	7,840	87	50	·6
100	170	93	8,275	83	45	·5

The average maximum total wood production per acre per annum in a 100-year rotation under German conditions, for German species, German management for different site-classes, leaving out the yield of the thinnings, which may possibly amount to 40 per cent. of the final yield, is as follows, in cubic feet :—

Site-class ...	I.	II.	III.	IV.	V.
Scotch pine	93	70	56	45	35
Norway spruce	154	127	93	78	56
Silver fir	158	128	102	77	54
Beech	106	85	70	50	35

The entire production of wood per acre of all the German forests is estimated as 50 cubic feet per acre per annum For France it is less than 40 cubic feet.

The yield table may also be shown graphically.



[There is nothing absolute in these tables; they are merely given as specimens.]

While in the natural unmanaged American forests the final crop of marketable timber, often 200 years old, rarely exceeds 8,000 cubic feet per acre, in the managed German spruce forests, fully stocked, and cleared of all undesired species, 3,000 cubic feet of wood may be found at 30 years; over 9,000 cubic feet at 60 years; and 14,000 cubic feet at 100 years.

The rate of production under these conditions will be 70 cubic feet for the first two decades, 240 cubic feet for the third decade, and 267 cubic feet for the fourth decade, being a maximum. After this the rate will decline, so that in the ninth decade it may be only 100 cubic feet, and at 100 years the average rate for the whole period has come down to 140 cubic feet. On poorer soils, less, down to one-half, of this production may by expected.

In the natural forest the same laws would obtain, but the economic result would be different, since the crop would contain tree weeds as well as the valuable species.

The most rapid growers are not generally, in the long run, the largest producers. For example, the fast-growing poplar, which is near the end of its life at 80 years, will scarcely have produced by that time 7,600 cubic feet to the acre; while the slow, shady, but persistent, spruce has by that time accumulated over 22,000 cubic feet and is still growing at the rate of 80 cubic feet per annum.

On good sites, and with fast-growing species, the culmination of the rate of volume growth occurs early and then declines rapidly. Thus the Scotch pine on good sites will attain its maximum at about the 30th year, with over 160 cubic feet per acre, and on poorer soils, ten years later: while the slow-growing beech shows its culmination at about the 60th year, with 190 cubic feet per acre.

The mean annual increment of a crop rises more slowly than that of a single tree, and more regularly, since it expresses all the variable conditions.

The maximum mean annual increment of a crop occurs when it is equal to the current annual increment; that is, the highest average annual production per acre per annum has been obtained when the accretion occurring through a series of years, divided by the number of years, is as large as the increment of the particular year.

This often occurs before the fiftieth year with light-demanding species on good sites, later on poor sites, and with shade-bearing species; but the value increment, depending on the amount of large-sized material, culminates very much later.

If a group of some hundred trees have grown together in a close crop of the same age, they develop so regularly and interdependently that the following relations will prevail: the contents of the average tree will be approximately equal to one-tenth of the volume of the three stoutest and the seven slimmest trees of the dominant stage, and the volume of the crop is then found by multiplying this amount by the number of trees involved:—

$$\text{Volume of crop} = n \times \frac{3\ \text{max} + 7\ \text{min.}}{10}$$

If the trees are arranged in size-classes, the average tree will be found to be about 40 per cent. from the largest. Thus in 500 trees, the 200th tree, counting from the stoutest, will be the average tree. Moreover, if these trees, arranged in size-classes, be divided into 5 groups, the first fifth will contain 40 per cent. of the total volume, the second fifth 24 per cent, the third 17 per cent., the fourth 12 per cent., and the last and smallest, only 7 per cent., of the total volume of the crop.

These interesting deductions from the yield tables are merely quoted to show that the forest grows under recognizable laws, by the help of which we can calculate not only the volume, but the value increment, and so obtain a basis for the management and development of the forest, and the realization of a given rate of interest on the capital involved in the forest.

Forest Exploration in the Bahr-el-Ghazal (Sudan).

BY C. E. MURIEL, I.F.S.

I HAVE just received from Mr. A. F. Broun, Director of Forests in the Sudan Administration, a copy of his report on the forests of the Bahr-el-Ghazal, and the following notes and extracts from that report may be interesting to the readers of the *Indian Forester*.

Mr. Broun left Khartoum on the 21st January 1902, by steamer to Meshra-er-Rek and thence commenced his land journey on the 5th February to Tonj, Wau, Chakchak, and Dem Zubeir; returning by a direct route to Wau, and by his former route thence back to Meshra-er-Rek, completing the journey of 700 miles by the 24th April 1902 The locality visited lies roughly between 26° to 29° E. and 7° to 8°-30′ N. and forms the north-western portion of the Bahr-el-Ghazal Province drained by the Tonj, Wau, Pongo, and Chell rivers.

Generally, the country can be divided into three zones: "Perennial swamps near the mouths of the rivers," "the somewhat raised alluvial flats further up, which are liable to inundation during the rains," "and undulating plateaux or hilly country in the upper reaches."

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Mr. Broun divides the forest for descriptive purposes into three divisions, corresponding with the drainage zones above noted.

In the perennial swamps the Ambatch (*Herminiera elaphroxylon*) is the only woody plant. It is reported to have become abundant only in the past few years. In the second zone tree-growth is scanty in portions periodically submerged, and the most common trees are *Mitragyne africana* (yielding most of the fuel at the Bahr-el-Homr wood station), *Sarcocephalus esculentus, Tamarindus indica, Crataeva religiosa, Maba abyssinica, Cordia sub-opposita*, and on poor soil *Euphorbia candelabrum*.

On higher ground villages are dotted about and the country is generally open, with solitary or small groups of trees or bands of forest alternating with open country, such trees as *Ficus sycomorus, Ficus platyphylla, Kigellia æthiopica, Borrassus flabelliformis, Acacia albida*, and *Balanites ægyptiaca* predominating. "Fierce fires sweep everywhere, and it is not wonderful if the condition of the forests is, on the whole, bad, and that the trees are generally crooked and hollow, the young growth mostly consisting of tufted coppice-shoots, which get killed down to the ground year after year until chance affords them a few years respite, which allows them to grow strong enough to resist further fires but not to be uninjured by them."

The forests of the third zone are composed of *Parkia filicoidea* (one of the largest trees of the Bahr-el-Ghazal), *Prosopis oblonga, Tetrapleura obtusangula* (another large tree), *Afzelia africana, Daniellia thurifera, Berlinia acuminata, Erythrophlæum guineense*, two *Cassias, Pterocarpus lucens, Dalbergia melanoxylon, Anogeissus leiocarpus* (yielding most of the timber used in constructing houses in the military posts at Tonj, Wau, Chakchak, and Dem Zubeir), *Khaya senegalensis*.

Butyrospermum Parkii is widely distributed and Bamboo (*Oxytenanthera* sp.) grows in narrow belts lining the water-courses in the highlands.

"The quality of the forests is at present not high. The best forests are those found in the broad, uninhabited stretch between Dem Zubeir and the Pongo, but even here the frequency of fires has prevented the stock from being at all uniform." * * * * *

"It is however satisfactory to note that even in such fire-worn areas there are still to be seen scattered here and there enormous trees, such as *Shandé, Homra, Bei, Nwana*, etc. * " *

"The most that can be said of these forests is that the large trees are very fairly represented, and that with proper treatment and protection some magnificent reserves could be evolved."

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* Shandé = Daniellia thurifera.
Homra = Khaya senegalensis.
Bei = Afzelia africana.
Nwana = Parkia filicoidea.

Khaya senegalensis, *Balanites ægyptiaca*, *Afzelia africana*, *Berlinia acuminata*, *Pterocarpus lucens*, *Tamarindus indica*, *Anogeissus leiocarpus*, *Borrassus flabelliformis*, and *Lophira alata* are among the trees recommended by Mr. Broun for their timber.

The following trees and climbers yielding latex—producing rubber or gutta-percha—are mentioned: *Landolphia florida* and *owariensis*, *Ficus platyphylla* and *Butyrospermum Parkii*.

Mr. Broun found that from *L. florida* the latex coagulated very rapidly and the wounds became coated with a film of rubber rendering collection difficult; the rubber was however of excellent quality.

L. owariensis was more abundantly found and is a very large creeper yielding a more copious latex than *L. florida*, but the collection of the latex in a pure state was not easy, and the latex coagulates with difficulty and yields an inferior rubber.

Ficus platyphylla is a large tree and yields an abundant latex, but Mr. Broun found it difficult to coagulate, though later he received good samples from boiling the latex The supply should be valuable as the tree is reported to be abundant between Wau and Meshra-er-Rek.

Butyrospermum Parkii yielded but little latex and this produced a gutta-percha that was hard and not plastic. The chief value of the tree therefore appears to be its edible fruit and the oil obtainable from its kernel.

Mr. Broun proposes to exploit the rubber by leasing out fixed tracts of country to be worked in alternate years. Where little control can be expected this system is likely to result in the destruction of the trees and failure of future supply of rubber. Such is the experience in Burma.

Mr. Broun advocates the formation of Reserves first on the Jur river near Wau, extending gradually to Tonj, and later to forests between the Pongo river and Dem Zubeir.

Transport is bad at present and the future value of the Bahr-el-Ghazal forests (apart from rubber) depends on the opening up of waterways now blocked by "sudd."

The necessity of fire-protection for forests that are to be worked is rightly insisted on, but the difficulties in the way of such protection are great: everywhere Mr. Broun went he met with traces of fire; this is not surprising, as the Dinkas and other tribes owning cattle fire the grass lands near the rivers to provide more tender herbage for their herds; hunting parties use fire in the pursuit of game; and travellers fire the grass to clear their path and for security against sudden attack by wild animals.

These habits will not be easily or quickly changed, but the earlier tentative measures of fire-protection are commenced the sooner will the people become accustomed to the restrictions which will be necessary.

The Bamboo Fungus of Burma, by SIR DIETRICH BRANDIS, K.C.I.E., PH.D., F.R.S., F.L.S. *Honorary Member of the Pharmaceutical Society.*

Last year I received from my old friend and follower in the Tharawadi Forests, Ko Way, through the kindness of the late Mrs. Ingalls, a most remarkable specimen, a cylinder, about twelve inches high, and just under three inches in diameter, of a soft but tough white leathery substance; on the outside with a horizontal shallow furrow at the bottom, and many raised vertical lines on the lower portion, which evidently had grown on the inside wall of a bamboo joint.

Mr. G. Massee, F.L.S., head of the Cryptogamic Department at Kew, at my request, kindly examined the specimen, and from the structure of its tissue and the presence of characteristic conidia formed on the inner surface of the cylinder, he identified it with *Polyporus anthelminticus*, Berk., which was described by the late Mr. Berkeley on p. 753 of the *Gardener's Chronicle* for

1866. As a rule this *Polyporus* forms thick, irregularly-shaped masses on bamboo stems, bearing a round top or pileus, which, on its underside, has innumerable holes or small tubes, lined by the spore-bearing hymenium. Like the European *Polyporus officinalis*, which grows on larch trees, it is an effective anthelmintic, and is also known as "Than mo." The *Madras Quarterly Medical Journal*, Vol V, p. 146, contains an article on it by Dr. Packman, giving the detail of four cases in which this remedy had been employed with complete success.

In the present case the spores, or the mycelium, must have entered the bamboo joint, probably, either while the tissue was young and soft, or at a later period, through a hole made by an insect, and must have formed this peculiar lining of the inner surface of the joint. I have not been able to ascertain the species in the internode of which this remarkable lining was formed, but I am inclined to think it was either Tinwa (*Cephalostachyum pergracile*) or Kyathaung wa (*Bambusa polymorpha*).

This note may perhaps induce some of my younger friends in Burma to study this interesting subject, and to record the result of their researches in the pages of the *Indian Forester*. It would be important to know whether such a soft, leathery lining is frequently found in bamboo joints and under what circumstances it is formed, also the species in which it occurs.

Chemical Analysis of the Rubber of Wrightia Tinctoria and Ficus Infectoria.

A QUANTITY of the crude rubber of *Wrightia tinctoria* and of *Ficus infectoria* was sent lately to the Agricultural Chemist for analysis. I give below an extract from his report for publication in the *Indian Forester*. By a mistake the rubber of *W. tinctoria* was sent in place of *W. tomentosa*. The method of extraction was to inflict wounds on the bark of the trees with a sharp stone; from these the latex oozed out and was caught up in a cocoanut shell as it dropped off, or was scraped oft with a leaf, or with the fingers, and dropped into the shell. In the case of the Wrightia, the flow of latex was more or less profuse and was easily collected as it dropped off the wounds, and such milk as adhered to the wounds was scraped off and dropped into the receiver. But with the Ficus the flow was never profuse and could only be gathered by scraping it off the wounds. The receivers when filled were allowed to stand uncovered three or four days to permit of complete coagulation of the contents. They were also put out in the sun for some time to effect this thoroughly. The contents were then removed from the shells before despatch. They adhered very closely to the shells, especially the rubber of the Ficus, and the shells had to be broken and some force used for separation.

Result of analysis.

	Wrightia tinctoria.	*Ficus infectoria.*
Water, gum, etc.	25·8	30·0
Resin	45·8	47·6
Caoutchouc	28·4	22·4
	100·0	100·0

" No 147 (referring to the Wrightia) consisted of the cream-coloured dry latex and was crumbly. No. 148 (referring to the Ficus) was a dark-brown coloured, sticky mass."

GEO. W. THOMPSON.

NARSAPATAM, MADRAS:
July 11th, 1903.

Ripening of Cones of Pinus Longifolia.

WOULD you be kind enough to allow me a small space in the *Indian Forester*, as I wish to say a few words upon the question of the ripening of cones of *Pinus longifolia*, in reply to Mr. E. M. Coventry's letter in the July number of the Magazine.

During the last 18 years I have collected seeds of *P. longifolia* for the use of the Imperial Forest School, Dehra Dun. I have noticed that the flowers are produced on the extremities of the branches every year, from February to April, just as the fruit is about to form. The growth of the branch on which the flower appears is thus checked: a side bud is now produced and branches begin to grow again in the same way as before; and the following year the flowers are again produced at the extremities of the new branches, and the side buds are produced by the growth of the terminal one being checked. At the same time the fruit is not formed on every branch, but on alternate ones. The old opened fruit remainsthree to four years on the trees. The age of the fruit can be found by counting the number of whorls of branches on which it is produced, and in the same way we can find the age of the tree by noting the number of whorls of branches on the stoms, and hence the age of the branch itself by counting the whorls of branches of the main branch. The fruit takes 12 to 15 months to ripen, and the seeds are generally and wholly shed in May of each year in Dehra Dun. It is true that there is an exception to this rule: the cones of which the ovules are not wholly fertilized, being weakly ones, do not open and therefore cannot

shed their seed at the proper time or season and such cones remain unopened on the tree, and finally during the rains they begin to decompose or decay and the seed is not allowed to escape.

I have just examined a cone, 15 months or so old, which had nearly half of its ovules fertilized and nearly half unfertilized; the seeds were quite overripe, but the cone being in so weak a condition, was unable to allow the seed to escape. I then examined another cone two years old, which had never opened and would probably decay on the branch. From the above it will be seen that the cones do not take more than 15 months to ripen, but exceptionally some very few cones, say 2 per cent., remain on the tree unopened, and therefore do not shed their seed.

Mr. E. M. Coventry says (page 276): "There appears to be a mistake in Gamble's *Manual of Indian Timbers*, page 706, regarding the period necessary for the cones of *chil* (P. longifolia) to ripen. This is given as 15 months, but I think it should be a year longer."

I think my note has explained this period, but if there be any doubt, I should be much obliged if Mr. Coventry would kindly let me see specimens of the cones which take 2¼ years to ripen, as I can count the age of the cones by looking at the branch on which they were produced. Such specimens would form an interesting addition to the museum of the I. F. School, Dehra Dun.

In the same article Mr. E. M. Coventry has pointed out: "According to Kanji Lal's *Flora of the School Circle* the *chil* (called *chir* in that circle—*Hon. Ed.*) flowers during February to April, and the seeds are shed in October next year. In this Division (Kangra) the seed falls from the cones in May."

I have stated that the seeds of *P. longifolia* cones are shed in May of each year at Dehra Dun, and not in October, but I will point out at the same time that in his *Forest Flora*, page 507, Sir D. Brandis says: "*P. longifolia* flowers from February to April; cones ripen from 12 to 15 months and shed their seeds in May." Sir D. Brandis further says: "Ribbentrop (*Arboriculture*, page 178), states that in the Punjab the seeds ripen in October, and that the best time to collect seeds is to pick the cones from December to March."

BIRBAL,

17*th July* 1903. *Curator, I. F. School, Dehra Dun.*

The Pests and Blights of the Tea Plant*

THE second edition of Sir George Watt's volume is now issued in a form modified and enlarged by the author and Mr. H. H. Mann. While it contains a voluminous compendium of the insects and blights recorded on the tea plant, a large portion of the book is taken up by chapters on the cultivation of tea and similar matters. As a reference work for tea planters the book fills a

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* *The Pests and Blights of the Tea Plant*, by Sir George Watt, Kt., C. I.E., and Mr. H. H. Mann, M. S. C. 2nd Edit.

distinct place, limited however by the ambitious nature of its scope, and should be useful to the few who have the knowledge and time to really make use of it. A large amount of information of a valuable and readable nature is to be found in the earlier chapters on cultivation, and for the planter this is probably the most important part. As an entomological book, the work is neither a useful scientific book of reference nor a really practical guide to planters. The authoritative work ends where the entomological chapters begin; no entomologist would describe a new species of *Psyche* (one wonders how the genus was determined) from a larval case alone without having the moth for reference, as is done in the case of *Psyche assamica*; and we question whether a practical entomologist would be satisfied to leave the treatment of the mosquito blight in such an unfinished condition. In this part the book lacks the authoritative weight of a specialist's knowledge, which would have prevented the authors reprinting the great mass of statements made by previous writers on the subject of mosquito blight for instance, and would have rendered a discussion of the value of parasitic fungi against insects unnecessary. Instances of this kind are numerons: the practically valuable part of the book could be reduced to small, handy, readable compass, which would at once tell the planter what was worth knowing.

Much the same may be said of the fungus blight chapters, with the exception that the material obtained was in some cases worked on by authorities such as Dr. M. Norrie or Dr. Butler. Throughout, the book has the stamp of an encyclopœdic compilation of information derived more largely from reports and literature than from any practical experience, and as such it admirably fulfils its lexicographical functions. We venture to think, however, that a far more useful book could have been written had the important pests alone been considered and thoroughly worked over. It is of far more use to a planter to know how he can fight one pest than to be told that there are 17 species of bagworms on tea, and be given their names with voluminous references to the literature which he neither understands nor has a chance of consulting if he did.

Better illustrations have been introduced in the form of photographs, and this marks an advance on the previous edition. In a compilation of this kind, however, it should at least have been possible to give fuller information regarding spraying machinery and insecticides. The appendix quotes five insecticides, including the mixture Gondal Compound, and two fungicides, and there is no hint given of how to apply most of them or where to get the machines.

Whilst there are many good things in the book it cannot be said to fill a want of the planter, the man for whom it is written.

V.—SHIKAR AND TRAVEL.

Indian Pheasants and their Allies.

By F. Finn, B. A., F. Z. S.

(*Continued from page* 300.)

Chapter VIII.

THE FOREST PARTRIDGES.

The Partridges which remain to be dealt with are pre-eminently forest birds, never going far from cover. Most of them have very short tails, but one, the Bamboo Partridge, has the tail longer than in any other Indian species, so as rather to recall a small pheasant in appearance.

The Bamboo Partridge.

Bambusicola fytchii, Blanford, Fauna, Brit. Ind., Vol. IV., p. 110.

This Partridge shows no difference in plumage according to sex; the male has a spur on each shank, but this may be present in the female also. The plumage is brown above, spotted with chestnut for the most part; the face is buff, with a dark band behind the eye; the breast dull chestnut with some white spots, and the under parts below this buff, with large black spots shaped like a heart. The tail is barred brown and buff, and the pinion quills are chestnut without bars. The bill is brown, the eyes orange-hazel, and the legs grey.

This partridge is about fourteen inches long, of which the tail measures nearly five; thus it is easy to distinguish it from any other species, the Spur-fowl, which also have longish tails, showing some bare skin about the eye.

The Bamboo Partridge affects forest and high grass, and ranges through a considerable portion of the eastern hill tracts, from the Assam hills south of the Brahmaputra, through Manipur, to the Kacheri hills between Upper Burma and Yunnan. It is shy and has a loud harsh call. Although the time—May and June—of breeding appears to be known, the eggs are as yet desiderata.

The various Hill Partridges (Arboricola) form an easily recognizable group of short-tailed birds with rather long spurless shanks, and particularly long, nearly straight claws. The sexes are usually alike, and they inhabit hill forests, keeping very close to cover, and occasionally perching. They are seldom if ever seen, and little is known about their breeding, except that they lay half-a-dozen or more white eggs on the ground. Their call is a low soft whistle and they are unobtrusive birds altogether; yet they are a well-represented group with us, numbering no less than

six species, none of which, however, are found in Southern India or Ceylon. An interesting point about these partridges is that they possess a row of small separate bones along the upper edge of the orbit, a sort of bony eyebrow in fact. No other bird of this family possesses them, although they occur in some other groups, the Trumpeters (*Psophiidæ*) of South America and the partridge-like Tinamous (*Tinamidæ*) of the same continent. The general plan of coloration of the *Arboricola* genus is very similar, all having olive-brown backs mottled with black, and grey flanks boldly spotted with white, and usually with chestnut edgings.

THE COMMON HILL-PARTRIDGE.

Arboricola torqueola, Blanford, Fauna, Brit. Ind., Birds, Vol. IV, p. 125.

Native names:—*Peunra*, *Ban-titar*, Hindi, of Kumaun and Nepal; *Roli*, *Ram chukru*, in Chamba; *Kaindal*, Kangra; *Ko kam-but*, Lepcha.

This is the only species of *Arboricola* in which the sexes are different. The male has the head bright-chestnut above and of a paler shade of the same colour over and behind the ear coverts; the eyebrows, sides of the head, and throat are black, with white edgings at the sides, and there is a white moustache streak. The breast is grey, separated from the black throat by a white band. The skin surrounding the eye is scarlet.

In the hen the crown is brown with black streaks, the sides of the head and the throat are chestnut with black spots; the breast is brownish, and has a rusty band above it; and the white spots on the flanks tend to run up to the breast, and are larger, However, old hens lose the breast spots, and young cocks possess them. Hens and young cocks have the skin round the face purplish-red. In all, the bill is black and the legs fleshy-grey.

This partridge is a little under a foot long, with a tail of only three inches, and a shank nearly two. The wing is six inches long. Males run larger than females.

The common hill-partridge is found at moderate elevations along the Himalayas from Chamba to east of Sikkim, and also in the Naga hills and in those north of Manipur. It ranges from 6,000 to 14,000 feet, but its common range does not go above 9,000.

BLYTH'S HILL-PARTRIDGE.

Arboricola rufigularis, Blanford, Fauna, Brit. Ind., Birds, Vol. IV, p. 126.

Native names:—In Kumaun and among the Lepchas this species seems to have the same names as the last; in the Daphla hills it is called *Pophu*. This species, like those which follow, appears to be a little smaller than the last.

It has the crown olive-brown with black streaks, and the eyebrows and face white, mostly speckled with black. The throat is chestnut with black spots, and below this is a band of plain chestnut, generally divided from the grey breast by a black band. The pure grey of the breast and the absence of black bars on the back will distinguish this bird from the hen of the Common Hill-Partridge.

The beak is black, the skin round the eyes dull dark-red, and the legs red.

This also is a Himalayan bird, ranging from Kumaun to the Daphla hills, but inhabiting lower elevations than the Common Hill-Partridge, since it is found from the foot of the hills to 6,000 feet only. It is also found in the Karennee and Tenasserim hills, and specimens from these localities are usually without the black band dividing the red neck from the grey breast. Four eggs of a dirty white colour were taken below Darjeeling early in July.

THE ARRAKAN HILL-PARTRIDGE.

Arboricola intermedia, Blanford, Fauna, Brit. Ind., Birds, Vol. IV, p. 127.

Native names :—*Toung-kha*, Burmese.

This is hardly a distinct species, merely differing from the last in having the throat entirely black instead of being only spotted with that colour. It agrees with the eastern variety of Blyth's Hill-Partridge in having no black band across the chest.

It is found in the Arrakan hills and North Pegu, extending to North Cachar and the Naga hills, and to Eastern Manipur, where it is common. The eggs were taken in Manipur in May; they were pure white, and six in number.

THE WHITE-CHEEKED HILL-PARTRIDGE.

Arboricola atrigularis, Blanford, Fauna, Brit. Ind., Birds, Vol. IV, p. 127.

Native names :—*Peura* in Sylhet; *Duboy Dubore*, Assamese, *San-batai*, in Chittagong.

In this species the crown is brown running into grey in front and chestnut behind, the feathers marked with black; a double eyebrow, of grey above black, is present, and the eye is surrounded by a black patch; the cheeks are white running into buff behind; the throat is black, becoming edged below first with white and then with grey, until it merges into the grey breast; the grey flanks have no chestnut borders to the feathers in this bird.

The bill is black, and the legs orange or lobster-red; and the reddish skin of the face shows through the feathers.

The White-cheeked Hill-Partridge extends from Assam south of the Brahmaputra into the Naga, Khasi, and Garo hills, Cachar, Sylhet, Tipperah, and Chittagong. The eggs have been taken in Sylhet on hillocks, at the foot of trees in dark and gloomy places; as many as four occurring in a nest. They are white, and measure rather over an inch in length.

THE RED-BREASTED HILL-PARTRIDGE.

Arboricola mandellii, Blanford, Fauna, Brit. Ind., Birds, Vol. IV, p. 128.

In this very easily recognizable species, the head, neck, and breast are chestnut of various shades; the chin and throat being pale and uniform, separated from the darker breast by a white band bordered below by black; the sides and back of the neck are spotted with black, and the eyebrows are grey, meeting at the back of the head.

Nothing is known about the colour of the bill, feet, etc.; indeed, the species is a rare and little-studied one, which has only been obtained from the low hills of Bhootan and Sikhim; and once from the northern part of the Goalpara district. However, it is so distinct from all the rest that it ought to be easily identified if met with.

THE BROWN-BREASTED HILL-PARTRIDGE.

Arboricola brunneipectus, Blanford, Fauna, Brit. Ind, Birds, Vol. IV, p. 128.

Native names:—Appears to be called *Toung-kha*, like *A. intermedia.*

This is a very distinct form, with the face and throat buff, the latter speckled with black, the breast brownish buff, and flanks greyish buff, with the usual white spots, but no chestnut; the white-spotted feathers are tipped with black.

The bill is black, the eyelids, the skin of the throat, where this shows through the feathers, and the legs, are red, the latter varying much in intensity of colour.

This bird haunts the evergreen forests on the eastern spurs of the Pegu hills, and also inhabits the ranges east of the Sittang river as far as Tavoy, as well as the Ruby Mines District. It has not been often found, and so very little is known about it.

One partridge of this group found in our limits differs from the true Arboricolas in not having the peculiar bridge of bone over the eye; it is also distinguished by possessing a large patch of white downy feathers under the wing, which is ordinarily concealed, even when the wing is lifted, by the feathers of the side.

THE GREEN-LEGGED HILL-PARTRIDGE.

Tropicoperdix chloropus, Blanford, Fauna, Brit. Ind., Birds, Vol. IV, p. 129.

This bird bears a close general resemblance to the other hill-partridges, but the brown of the upper part is more closely mottled with black, and the sides of the body pale rusty with black blotches; the crown is dark brown, the eyebrows also brown, with white streaks, and the face and throat white speckled with blackish. Below this the front and sides of the neck are chestnut with black spots, and then the breast is coloured brown continuously with the back.

The bill is dark-red at the root and greenish at the tip; the skin round the eye purplish; and the legs pale-green.

This partridge, which agrees with the Arboricolas in habits as in appearance, is found, locally, in the evergreen forests all through Tenasserim down to Tavoy, and on the eastern slopes of the Pegu hills. Outside Indian limits it has been obtained in Cochin China.

There remain two very beautiful short-tailed forest partridges, each of which claims a genus of its own.

THE CHESTNUT WOOD-PARTRIDGE.

Caloperdix oculea, Blanford, Fauna, Brit. Ind., Birds, Vol. IV, p. 131.

In this bird the tail, though short, is longer than in the Arboricolas, the toes, and especially the claws, are shorter, and the hinder toe bears a mere rudiment of a claw. The sexes are alike in plumage, but the male has short spurs, which may be one or two on each leg.

The plumage is very characteristic, the general colour being a rich chestnut, barred with black on the flanks, where also white bars may be present; the back is black, pencilled with white above and with chestnut lower down; the wings are brown with black spots, and the tail black.

The bill is black, the eyes dark, and the legs dull-green. The length is just under eleven inches, the wing being nearly six, and the tail nearly three; the shank is nearly two inches long.

This is a forest bird, very little known, and apparently one which Europeans have never even seen in the wild state. It is found in the Malay Peninsula, and extends into the southernmost part of Tenasserim, where it inhabits dense jungle about Bankasoon. A sort of local variety of the species inhabits Sumatra.

I have ventured to call this bird the "Chestnut" Partridge, as "Ferruginous," the epithet usually imposed on it, is a rare and clumsy word.

THE RED-CRESTED OR ROOLOO PARTRIDGE.

Rollulus roulroul, Blanford, Fauna, Brit. Ind., Birds, Vol. IV, p. 111.

This lovely bird very properly occupies a genus all to itself. It has a very short tail and rather long legs, with feet of the ordinary size, and the claw of the hind toe rudimentary or altogether absent. A tuft of long hair-like feathers is found on the forehead in both sexes, which otherwise differ widely, although neither has spurs.

The male, besides the tuft of bristles, has a full and large crest of loose-textured feathers on the head, which is of a dark-red colour. The general body-plumage is steel-blue with a rich satiny gloss, changing in some lights to green; the wings are brown, and there is a white band across the forehead.

The hen has no crest, and is grass-green without gloss, with chestnut wings and slate-coloured head.

In both sexes the eyelids and feet are brilliant red, the male has the base of the bill red in addition; but in the female it is all black. This bird about equals the wood-partridges in size, being about eleven inches long; the wing measures five-and-a-half inches, and the tail two-and-a-half; the shank about one-and-a-quarter. Females are a little smaller than this.

This partridge has a wide range, being found in Borneo, Java, Sumatra, Siam, and the Malay Peninsula, where it extends into the south of Tenasserim near the Pakchan river. It is a forest bird, and gregarious in its habits, being found in small parties of half-a-dozen or more, comprising both males and females. It is described as much more lively in its movements than the Arboricolas, running about like a quail, and not scratching so much as the others The note is a soft, pleasant whistle. Nothing is known about the breeding except that the egg is buff and about an inch-and-a-half long. This beautiful and gentle little partridge would be a most charming aviary bird, but unfortunately it is not much exported, at any rate nowadays, and Mr. W. Rutledge, who imported the first into Calcutta many years ago, tells me that the late ex-King of Oudh was much pleased with them and bought them at a high price, naming them "The King's Fancy." The name "Rooloo" is that by which Mr. Rutledge calls these birds, and I presume it is the native name in some parts of the Far East.

Our Specialist-in-Chief on 'Spike.'

[Extracts from the Editorial, *Indian Planting and Gardening*, August 1st, 1903.

"In a recent issue we reviewed the steps taken by the Mysore State with a view to ascertaining the causes of 'spike' disease in Sandal wood trees . . . . . Mr. Barber seems to have come nearest to the cause of the trouble . . . . . Dr. Butler has

utterly failed to follow up the clues which Mr. Barber has given . . . . . We now come to Mr. Muthunnah's (Conservator of Forests, Mysore) report and conclusions . . . . . . We cannot agree with this line of logic . . . . . Mr. Muthunnah's reasoning is therefore at fault . . . . We believe 'spike' to be a contagious disease . . . . . ."]

And has it then come here to stay,
This dread and fell disease?
The thing that bears the name of 'spike,'
And effectually spikes the guns of life
Of the sweet-scented Sandal tree.
If you wish to know, if you really ask,
What hope there is for this tree so dear,
Referred you are to the lines above

By the Editor, *I. P. & G.*

You specialists are out of it,
Both Madras and India's too,
And the Mysore Forest Conservator
Adds another to the 'ignorant' crew.
For your arguments are foolish,
And you 've all completely failed
To tell us any thing about
'Spike' in the Sandal tree.

Thus, the Editor, *I. P. & G.*

For when the latter shrieked aloud
For specialists right throughout,
In trees and crops, and bugs and soils,
Manures and drains; he meant, of course,
A post above the lot to fill.
Self-appointed Specialist-in-Chief,
He'd let 'em know when they went wrong,

Would the Editor, *I. P. & G.*

So look you to it Scientists,
No matter what your lines,
Chemic, Botanic, Entomologic,
As sure as fate if you don't make
Discoveries quick and marvellous;
If you dare to point out that the 'Origin' took
The Father of Science decades three to compile,
You 'll be brought to book, by hook or by crook,

By the Editor, *I. P. & G.*

THE VAGRANT.

Resistance of the Australian Jarrah Wood to fire.

AFTER a fire which took place some months ago in the Victoria Docks the Sub-Committee of the British Fire Prevention Committee reported as follows:—

"At the north-eastern end of the yard, and about 36 feet away from the shed, was a pile of Jarrah wood some 30 to 40 feet high, and having a frontage to the shed of about 36 feet, and to the basin of about 100 feet. Projecting in front of this pile of Jarrah wood for about 10 feet, and abutting upon it, on the shed and basin sides, were piles of deal about three quarter the height of the Jarrah stack, and these were very largely consumed by the fire, the flames from which played on to the pile of Jarrah, generating considerable heat; but though the Jarrah bore the brunt of the fire, as what wind there was blew in this direction, comparatively little damage was done to this pile and this was confined to the north and west faces, the fire failing to penetrate far into the interior. Your Sub-committee are of opinion that, but for the resistance offered to the fire by this stack of Jarrah the conflagration would have assumed much larger proportions, as in the rear and on the south side were large quantities of deals, and, had they ignited, the task of the fire brigades would have been far larger and more difficult." The report further stated that "the wooden sides of the railway trucks between these piles (deal) and the shed, were entirely consumed, only the ironwork and the decking remaining, leaving the Jarrah wood paving blocks (which were in the trucks) intact, but for charring on the face of the outside blocks directly exposed to the fire."

The Street, commenting on this fire in its issues of October and November, 1902, said: "There can be little doubt that if the timber in the mill and in the yard had consisted wholly of Australian hardwood, instead of deals and hardwood in juxtaposition, the fire would not have made much headway before being mastered by the brigades and the dock companies' floating engines. After all, an actual fire is the best fire test, even though an expensive one for the moment."

Our enterprising cousins on the other side of the Atlantic would probably take a hint of this kind and send over a few loads of a new timber they wished to place on the market and see to it that it got 'placed.'

Forestry at Ci'cester.

AT a meeting of the governing body of the Royal Agricultural College, Cirencester, held on the 4th instant, the report of the Board of Agriculture Committee on British Forestry, recently presented to Parliament, was taken into consideration, and it was unani-

mously decided, in consequence of the recommendation of that report, to remodel and largely develop the teaching of forestry at the College in connection with the estate management branch of the curriculum. In furtherance of this object it was unanimously resolved to create a new Chair, to be entitled the Chair of Estate Management and Forestry, and to appoint thereto a special Professor or Lecturer who shall be required to devote all his time to the duties of the Chair, and who shall have had good experience not only of the management of woods in this country, but also of the continental system of sylviculture followed in the State and communal forests of France and Germany. *This will be the first attempt in England to deal with this important question on these lines*; and inasmuch as a large proportion of future landowners and managers who attend regular courses of College instruction pass through Cirencester, the results will be watched with much interest.— *The North British Agriculturist.*

As we go to press we have received the news that Dr. Schlich, F.R.S., has been appointed Honorary Professor in the Forestry Chair, recently created at this college. We feel sure that the Service in India will join in according their heartiest congratulations to Dr. Schlich on being thus the first to fill a Forestry Chair in England, whilst they will also be extended to the Governing Body of the Royal Agricultural College in appreciation of the enlightened manner in which they are dealing with a much neglected question.—HON. ED.

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Notes on Indian Trees. I – Note on Kongu (Hopea) in the Tinnevelly District.

BY P. M. LUSHINGTON.

1. *Different kinds.*—The native woodcutter distinguishes two kinds of kongu, the Vellai kongu and the Karin kongu. Of these the former is considered by far the more valuable. The distinction between them is said to be that the Vellai kongu has a smoother and lighter bark and smaller leaves. A further kongu known as Nir kongu is known in the Srivilliputtur Taluk and the wood is considered of little value.

2. *Botanical identification.*—Beddome considers that the Vellai kongu of Tinnevelly District is the *Hopea wightiana* closely allied to *Hopea parviflora*. It seems possible that both these species occur. Beddome has identified the Karin kongu as *Balanocarpus utilis*, but also states that the *Balanocarpus erosa* occurs in the Tinnevelly mountains. The chief difference between these two species appears to be the fruit. I carefully examined some of the trees and they all appear to me to have the fruit of *Balanocarpus erosa* rather than *Balanocarpus utilis*. The name Karin kongu probably covers both species. Mr. C. A. Barber, who had no opportunity of examining the fruit, identified the flower as *Hopea longifolia*, which Beddome says it greatly resembles. The specimen of Nir kongu sent me was undoubtedly the *Filicium decipiens*, a tree of no particular value.

3. *Forest identification.*—To the Forester there is no necessity to go into nice botanical distinctions, and we may well follow the native classification and consider the two kinds, white kongu (including the *Hopea parviflora* and *wightiana*) and black kongu (including the *Balanocarpus utilis* and *erosa*).

4. *Difference between White and Black kongu.*—Undoubtedly the chief distinction between the two is the leaf. The white kongu has a small, rather light green leaf, with thick foliage,

somewhat resembling the beech. The black kongu has, on the other hand, a dark green, hard, big leaf, and looks very like a mango. As regards measurement, I took two fair samples of well-grown leaves which gave the following measurements :—

White kongu 4″ × $1\frac{1}{10}$″.

Black kongu 6″ × 2″.

Both trees when young have a smooth bark, which, however, is undoubtedly much darker in the black kongu. The white kongu is generally a light brown and the black kongu distinctly dark brown. Both are greyish in places. As the tree grows older the white kongu continues lighter in colour and less rugged. The most noticeable point of distinction however seems to be the tallow-like gum which exudes from the black kongu, which is either entirely absent or very rare in the white kongu. A further difference is the fruit. This is most marked and constitutes a great difference in the sylviculture of the two trees. The white kongu is a true *dipterocarp* and has a light seed about the size of a pepper corn, with two large wings; whilst the black kongu is a heavy nut-like fruit, in a cup formed by the calyx, and is devoid of wings. It is larger and heavier in the *Balanocarpus erosa* than in *Balanocarpus utilis.*

The black kongu is always to be seen in flower at the end of April, May and the beginning of June. I have never seen the white kongu flowering, though I have looked for it at the same season ; also in February and March. The distinction which the woodcutters make in the wood does not appear to be marked. Both woods show an outer wood white to yellow and heartwood light to a dark yellowish brown. I think the preference given by the woodcutter to the white kongu is due rather to the fact that more of the white kongu trees are found to be sound and, after a careful examination, I have come to the conclusion that the age of maturity is lower in the black than in the white kongu.

5. *The uses of kongu.*—Kongu is by far the most valuable wood in the Tinnevelly District, and is worth four times any other sholah or semi-sholah wood.

It is largely used for posts, beams, rafters and planks. The posts for the wire-fencing in the Palamcottah compound are white kongu. They were put up in 1902. The rafters were very largely used in the railway buildings. Beams were used for the Jubilee Bridge in 1902. Planks have been used for some years in the Tambraparni Bridge near Papanasam and have lasted well. Sleepers were cut in 1903 and sent to the South Indian Railway for trial and are of good quality.

6. *Locality, elevation, soil, etc.*—The lowest elevation at which I have found kongu is just below 1,000 feet near the

Kudivarai depôt; and the highest is on the banks of the Pi Ar, near the Sengalteri bungalow, an elevation of 2,800 feet. The lowest were the black variety and the highest the white: but between these two elevations both kinds are found very commonly growing together. It is essentially a semi-sholah tree and seems to prefer a rich soil, but I have found well-grown saplings growing out of the crevices of slab rock on the banks of the Servi Ar and Kudivarai Ar, and both species seem able to support themselves in such situations. One fact in connection with kongu has particularly struck me—it is found mainly on the hillsides bordering on large rivers, and even when a little distance away from the river it is invariably on the bank of a ravine. The close proximity of running water appears to be essential to its growth.

7. *Congeners.*—I have in several places seen kongu growing with, or close to, Vengai in the moister parts of the higher deciduous forest. More frequently it grows with *Pterospermums, Vitex altissima, Diospyros* (several species), and *Filicium decipiens.* Frequently there are patches of nearly pure kongu forest, and it is a tree which is nearly always found in large patches.

8. *Size and exploitability.*—The tree appears to grow to an enormous size and to great age. I have seen a considerable number of trees of over 15 feet girth, and one or two over 20 feet, with a bole of 60 to 80 feet.

One tree is said to have produced over 200 rafters of nearly 2 cubic feet each. I am inclined to think that many trees have been left until far beyond the age of maturity, as nearly all the large trees now standing are hollow and very unsound. I have been unable to obtain data as to the rate of growth, but as a rough guess I should estimate that it takes from 100 to 150 years to obtain a girth of 8 feet, which I consider would be the best size at which to fell the trees.

9. *Enumeration and Estimates as to the number of trees.*—I have had no time to make regular enumerations, but, owing to a note by Mr. A. B. Jackson, who considered that the supply of trees was likely to fail, I have made some careful inspections with a view to ascertain if the tree is decreasing. As a result I am convinced that the tree is largely increasing in numbers though the number of mature trees fit for felling is small.

The area chiefly subjected to test was the west bank of the Kudivarai Ar from its junction with the Servi Ar.

On the bank of the river I found three good sound trees of fair size and some fine poles of 1½ to 3 feet girth, as well as a good number of seedlings. From there I passed up the hill through a small patch of semi-sholah with a few kongu saplings, then through

grass and deciduous forest (probably an old Kani clearing), and then entered into a fair sample of kongu forest. Here I took an enumeration with the following result:—

Sample area.—20 yards × 100 yards (under ½ acre).

	Over 6′ girth.	3′—6′	Saplings up to 3′
Karin kongu...	1	2	31
Vellai kongu...	*Nil*	1	3

I then met with more grass land for a small distance, and in the next bit took another sample area.

Sample area.—20 yards × 130 yards (just over ½ acre).

	Over 6′	3′—6′	Saplings up to 3′
Karin kongu...	3	7	48
Vellai kongu...	3	5	1

Just outside this area I found the whole hillside down to the river covered with a mass of kongu saplings (some thousands in number) up to 1 foot girth with 7 mediums and 7 mature trees. All were Karin kongu.

Again I passed through a small piece of grass land and once more entered kongu forest. Here in a length of about 200 yards I met with one large Vellai kongu tree with a mass of seedlings all round it and ten beautiful mediums running up to nearly 6 feet girth. The rest of the forest is similar up to the turn of the Kudivarai Ar. So that the whole of this forest is well stocked. The belt of kongu forest I estimate to be about a quarter of a mile wide from the river bank.

I am informed that higher up the Kudivarai Ar there is a thin belt of kongu forest on either side of the river for a distance of two miles. Crossing the river I studied the forest on the north bank. Here I found some felled trees, and in quite a small area 15 to 20 mature black kongu trees (some marked for felling), the great majority of which were hollow. Here again there are patches of almost pure black kongu forest in which the large number of medium trees was particularly noticeable.

On the east side of the river I found, just at the turn, an absence of big trees but a good lot of mediums, chiefly white kongu, with a good many saplings.

All along the east side, from the turn to the Brandyodai, near the Kudivarai depôt, the forest is well stocked, especially with black kongu.

My next examination was along the south banks of the Servi Ar from its junction with the Kudivarai Ar up to the waterfall, a distance of about three miles. Here I found a considerable number of large white kongu trees (some very large), a few of which seemed to be sound. In places the saplings were exceedingly numerous, and though there were a few scattered mediums, yet

that class was by no means well represented. In places some splendid *Vitex altissima* and a few *Diospyros ebenum* were found growing with the kongu. There is a peculiar absence of black kongu. I am told that the growth on the north bank of the river is very similar. The belt of kongu is very narrow and hardly more than a furlong broad, though the trees in places grow up the sides of the ravines more into the interior of the forest. It was from this locality that the large tree noted in paragraph 8 was said to be felled.

In this locality exploitation is difficult.

In addition to these places, I have seen very fair regeneration, and, in places, masses of saplings in the Tirukurangudi working circle, the banks of the Peyar and Tambraparni near Kannikatti, and the banks of the Kusanguli Ar (Nanguneri Taluk). In all these places there are very few mature trees and a decided absence of mediums. At Vettilayuthumedu and Oadipulaval there are a large number of mature trees (30 reported to be sound) and Forester Srinivasa Row reports that there are numerous saplings.

As a result of my inspections I am satisfied that the area of kongu forest is limited, but that wherever the tree exists there is no likelihood of its disappearance. On the contrary, though considerable time must elapse before timber in large quantity is obtainable, the kongu tree appears to be gradually spreading over a larger area, whilst in all the principal kongu forests the natural regeneration is excellent. In most instances the black variety is predominant.

10. *Distribution.*—The kongu appears to be confined to the Nanguneri and Ambasamudram ranges. In those ranges it is only, as far as I have been able to ascertain, to be found in the following places :—

(1) Nanguneri Taluk.

(*a*) *Tirukurangudi working circle.*—The tree is confined to a small area along the valley of the Kombi Ar and running up some of the ravines falling into it. In coupe XI-A 40 saplings, mostly under 3 feet girth, have been marked as standards. I saw one particularly fine young tree of about 3 feet girth with a bole of 50 feet. There is one large sized tree in the same coupe which should be retained as a seed bearer. I am informed that there are also a few trees in coupe XI-B, which should all be marked as standards.

In coupe X there is one very large tree of over 20 feet girth. This has given rise to a large number of saplings up to 2 feet girth.

(*b*) *Sengalteri.*—The kongu area is small and the tree is only found on the banks of the Pi Ar. I saw one big tree and a good number of small ones in this locality. Further investigation is needed.

(c) *Kusanguli Ar.*—On the side of this river, close to the Singampatti boundary, I saw a considerable number of young trees. I am informed that higher up this valley, on one of the hills overlooking the river, there is a fine growth, but for the most part young trees.

In this taluk all the trees are of the white variety.

(2)—AMBASAMUDRAM TALUK.

(a) *Kannikatti.*—The kongu area extends from the valley of the Ullar, up the Tambraparni valley, and as far as Kannikatti south of the road. Near the Ullar there are some large trees of black kongu and there is a small plantation near the Ullar bungalow which is too dense and requires gradual opening out. On the slopes near Kannikatti most of the marketable trees have been worked out. The few large trees left must be retained as seed bearers. There is, in patches, a fine growth of young saplings. Here the trees are of the white variety. There is also a good sprinkling of trees along the valley of the Peyar with a few big trees.

The area under kongu in this neighbourhood is pretty extensive, but the growth is very scattered and the tree occurs only in patches.

(b) *Kodumadi.*—On the western side of the Servi Ar at the foot of Oosipothai there is a fair growth of black kongu. There are a few big trees and some fine young poles of 1½′ to 3′ girth and a large number of saplings. The kongu belt is a narrow one.

On the banks of the Servi Ar from the Oosipothai to the waterfall there are a good number of big white kongu trees, a few half grown trees and a large number of seedlings. The big trees are for the most part hollow.

(c) *Kadivarai.*—This area has been fully described in paragraph 9. It is decidedly the best stocked area in the district and covers about 600 acres which can be easily worked by an extension of the present cart road.

(d) *Vetilayuthu Medu and Ondipulaval.*—These two areas are at the two main sources of the Thalayuthu Odai. The actual area covered by kongu is not large, but I am informed that they are well stocked and contain a large number of mature trees, many of which are hollow. A large number of trees were felled in 1898, out of which there are reported to be 77 which contain timber fit to be utilized. The trees are reported to be mostly black kongu, and there are a number of saplings.

This valley could be easily opened up and other trees made available for felling, but, except for the removal of felled trees, no work should be undertaken till the opening up of the valley has enabled further investigation to be made.

(e) *Sivasylam.*—In the old working circle coupe I, over 170 trees were marked as standards. The growth is confined to a small area along the valley of the Kal Ar and its main affluents. The area is very inaccessible at present and requires opening out

(f) *Kariar.*—On both sides of the river near Sembagatota there are some trees.

11. *The sylviculture of kongu.*—The difference in the leaf and the nature of the seed must entail considerable differences in the sylviculture of the two species. The black kongu, with its large and heavier leaf, is more of a shade lover than the white variety. The difference in the seed is evidently due to the same cause. The lightness of the white kongu seed, with its attached wings, causes it to be spread over a much larger distance and to settle in places where there is plenty of light. The heavy seed of the black kongu falls directly to the ground, and, under the heavy shade of the parent tree, hundreds of young seedlings readily spring up. A mixed forest of the two kinds of kongu would be similar to the mixture of oak and beech in Europe, and in order to favour white kongu, there must be larger clearance overhead. There should be no difficulty therefore in raising pure forests of the two species, taking precautions that the white variety is not suppressed. As the white variety springs up more quickly when a clearance is made, it should get a start of the black which will be favourable to both species.

As a result it appears that a treatment of regular high forest with thinnings should be particularly applicable, and the more the two trees can be induced to grow in unison the better should be the results. This seems to be the ideal to be aimed at, but will take many years to carry out.

Hitherto the sylvicultural treatment of the two trees has not been much considered. Wherever a marketable tree has been found it has been felled, and yet the reproduction is found fairly satisfactory, because it has been useless to fell the hollow trees which for some years must have proved such useful seed bearers.

In the Tirukurangudi and Sivasylam working circles the trees left as standards, being of the white variety, should turn out useful timber trees, and the opening out of the forest would certainly have tended to increase the number of seedlings had the standards been capable of giving mature seed. The effect of this treatment should be carefully watched. In coupe X of Tirukurangudi a different treatment has been applied—an improvement felling has been made. As there is no demand for inferior trees it has been found necessary to let in light and air by ringing all the trees except those of valuable species. Owing to the recuperative powers of the sholah trees, the dying of the trees is considerably delayed, and the whole of the ringed trees will, in my opinion, not die for at least three years. This gradual letting

in of the light should be highly favourable to the growth of kongu, and it is an advanced form of this operation that I intend to apply to the larger kongu forests. Wherever the natural regeneration is sufficiently advanced, it will only be necessary to ring every tree that is not kongu and to cut any mature kongu tree that is not hollow. Where the kongu is hollow it will be useful as a seed bearer and will do less damage by dying off naturally than by being felled. Where large trees exist but no regeneration, it will be necessary, in the case of white kongu, to ring every tree within a radius of three chains to the seed bearer; in the case of black kongu, a distance of one chain should suffice. Where there is no kongu it will be better to retain the forest in its present state, removing all marketable trees of over 6 feet girth. Of course any ringed tree which has a marketable value may be removed. In the case of kongu itself no tree should be considered mature until over 8 feet girth, unless it shows distinct signs of decay.

This system of improvement felling with a view to convert the forest into pure kongu, to be subsequently worked on the high forest system, can only be applied at present to Kudivarai. In Kodamadi and Kannikatti it will be better to allow the areas to fall within the ordinary timber working area, taking out as much as possible of the other timber which is found in conjunction with kongu and ringing all valueless trees in the same group.

In Vettilayuthumedu nothing can be done at present except the removal of timber already cut and the opening out of the valley by a road (which can easily be constructed) and the building of a small rest-house to enable a proper investigation of these forests. When this has been done, it will probably be advisable to apply the Kudivarai system to this area also.

At Sivasylam the patch of kongu is too small and inaccessible for working at present, and rest will be prescribed to enable the trees in existence to mature. At Kariar the greater part of the trees fall within the area under dispute by the Kattalamalai hukdar, so it is inadvisable to make any prescriptions at the present time.

12. *Conclusion.*—Considering how little attention has been given to the sylviculture of this valuable tree, the kongu forests are, in my opinion, in a better state than would naturally be expected. Considerable damage has however been done, especially in 1898, 1899, by reckless fellings entrusted to native subordinates and contractors. I consider that the forest is of such value, that in the kongu area all the marking and ringing operations should be under the direct supervision of the District Forest Officer, or if that is found impossible, under a really intelligent and well-trained Ranger, and not left to foresters utterly ignorant of all sylvicultural principles, as has been hitherto the case.

The Training of Forest Officers.

THE appointment of a Committee by the Secretary of State for India to report on the desirability of continuing Cooper's Hill as a College for training Engineers and Foresters for the Indian service raises the question of what should be done if the Forest Service is deprived of its present Alma Mater. As I have been closely connected with the Indian Forest Service since its first formation, and have for many years been intimately associated with the education of Forest Officers, first at Nancy and then as a visitor of Cooper's Hill College, I venture at such a critical time to offer a few remarks on the present system of training and on future requirements, hoping that some of my younger fellow workers may be induced to offer their comments and observations on what I may here adduce.

It may be safely said that no branch of the Indian Administration, not even the Civil Service itself, needs more urgently the services of educated gentlemen than does the Forest Service, controlling as it does 208,000 square miles of forest lands. or more than one-fifth of the area of our Indian Empire, and administering a revenue of nearly two crores of rupees, with a staff of upwards of 15,000 men to do its work.

Sir Dietrich Brandis, to whose self-sacrificing zeal and wise foresight the Indian Forest Service owes so much, from the very first clearly recognised the importance of employing specially trained men as Forest Officers, and in 1866 instituted the system of training young Englishmen in the Forest schools of France and Germany as officers for the Indian Forest Service. In 1869 the first batch of seven of these men were sent out to India. Under this system the English pupils were trained with and attended the same lectures as the other pupils in the schools to which they were attached, and thus benefited by the instruction of the very best Professors of Forestry on the Continent, and further had the unrivalled advantage of continually, during their training, seeing the practical working of large forest areas, administered in the best possible manner. This system was continued till 1866, and was highly successful. The Forest Officers who were trained under it and sent out to India, proved themselves to be excellent practical Foresters as well as thorough gentlemen and men of the world; and I believe I am right in saying that there is not a single instance of one of them having been dismissed the Service on any ground whatsoever. It is specially to be remarked that this system was not abolished on account either of the stamp of men sent out to India. or of their training in Europe, but on grounds of a totally different nature. Since 1887 inclusive, the Forest Officers who have gone out to India have been trained at Cooper's Hill, and it is due to Dr. Schlich and his fellow workers there that the same high standard of efficiency as had been reached by our

pupils in the Continental Forest schools was maintained there; the difficulty as to the want of regularly organised forests in Great Britain for the practical instruction of the pupils having been met by sending them for the third year of the training to reside in the forests with Forest Officers in Germany.

It is to be regretted then that when we have a system of education that gives satisfactory results, we should, if Cooper's Hill is abolished, be brought face to face with another change, and have to devise another new scheme for educating our Forest Officers; but as the retention or otherwise of Cooper's Hill will no doubt chiefly depend on what is determined upon for meeting the requirements of the P. W. D. in respect to Engineers, it is well to consider carefully what courses are open to us to meet the necessities of the Forest Department in case the change is forced upon us, and in this contingency three courses seem to be open:—

1st. To revert to the system of Continental training.

2nd. To substitute one of the Universities for Cooper's Hill, and to send the pupils for their instruction in practical work to pass a third year, as at present, in the forests of Germany or France.

3rd. To utilise the Dehra Dun Forest School to train the upper as well as the subordinate staff of Forest Officers.

I will deal with the last proposal first as, though plausible, it seems to me fraught with danger to the efficiency of the Forest Service. But as it has been put forward by responsible people, the many disadvantages which would attend it should be clearly set out.

First on general educational grounds, for to send the pupils to the School at Dehra Dun for training, instead of giving them a European education, would be equivalent to sending boys to Bishop Cotton's School in the hills in India instead of to a Public School at Home. In short, they would lose the broadening of mind and general development of character which are indispensable to those who have to administer our Indian Empire.

Secondly, it would entirely fail in what we most want namely, to imbue the minds of our young officers with the principles on which large areas of forest can be managed on regular economic principles, as illustrated in the great forests of the Continent of Europe.

Thirdly, it would be unadvisable to train the upper and lower staff of Forest Officers together, as they have different functions to perform and require a totally different standard of education. Moreover, the educational Staff for such a school would be very expensive to maintain in India, and would draw too

heavily on the resources of an already overworked and undermanned Department. It cannot be too strongly insisted upon in educating the upper staff of the Forest Service that broad principles, which are of universal application, are far more essential than local technicalities, which an educated mind speedily acquires on the spot. It is earnestly to be trusted that any scheme of training Forest Officers of the Imperial branch in India will never for a moment be entertained.

I will next consider the course of reverting to the old system of Continental training. If Cooper's Hill is to be abolished I frankly confess that, failing any better plan, I should be entirely satisfied to revert to the old system. It has supplied the Forest Service in the past with a body of able men, who have proved themselves in every way fitted to carry on the work of large forests—men who as a body have worked in sympathy with the native population of the forests, while they have safeguarded the interests of the State,—and in times of famine have rendered valuable services in alleviating the distress of the starving people. I do not know where better all round men can be found than those who now administer the Forest Department in its upper branches, all of whom were trained either in Germany or France. I am well aware however that any such plan would be strongly opposed by many persons who consider that men who are to hold important positions in India or our colonies should be educated at Home, and who think, wrongly, in my opinion, that a Continental training may deteriorate their character. It would also be opposed by a numerous and growing class of people, both in England and in Scotland, who are really interested in forestry, and who fear that if our Indian Forest pupils are trained abroad, all hope of establishing a Home Forest School would disappear, and with it the re-afforestation of the waste lands in our own Islands. With this feeling I fully sympathise, but I am only treating here with what I think best for the Indian Forest Service.

Coming then to the other proposals, *i.e.*, of attaching our Forest pupils to one of the Universities for two years, supplemented by one year's practical work in the Forests of Germany and France, I have hardly sufficient knowledge myself to say which University would be best suited for this purpose, but as it may be assumed that half the men who go up to Oxford or Cambridge do so as much for athletics as for serious study, my inclination would be to send them to Edinburgh, where the bulk of the students are hard and conscientious workers, and where there is already a class for Forest students. In any case the teaching of forestry would have to be carried out, as at Cooper's Hill, under special Professors, who should have disciplinary control over all their work, and under whose direction the pupils should attend such other lectures in the University as might be deemed advisable. It may be urged as an objection that the time allowed would

hardly admit of a degree being obtained at any University, but this must never be extended at the expense of the Continental portion of their work. In any case, either at Oxford, Cambridge, or Edinburgh, the bulk of the pupils would probably be unattached, and this would necessitate careful supervision by their own Professors to keep them up to their work. No doubt some social advantages and prestige are attached to a University education, and I do not wish in any way to underrate these.

On the whole if Cooper's Hill is abolished, and the Continental training cannot be reverted to, I think that the University course, supplemented by at least a year's practical work in the forests of Germany or France will furnish the Indian Forest Service with a body of men worthy to carry on the excellent work of those who have gone before them. I hope, however, that Cooper's Hill may still be allowed to continue its useful existence and to supply the Indian Forest Service with the high class of trained men that it has done in the past.

GEORGE F. PEARSON, *Colonel.*
Formerly Offg. Inspector-General of Forests in India and in charge of pupils at Nancy.

What should the Madras Forests Yield.

In 1882 Sir Dietrich Brandis estimated that the forest revenue of the Madras Presidency should amount to Rs.9,00,000, and based his proposals for establishment and other expenditure on this figure, so that while the forests yielded no net revenue, neither were they a charge on Government. Within twenty years the forest revenue has risen to Rs. 25,00,000 and the expenditure to Rs. 17,50,000; that is to say that the revenue has nearly trebled, while the expenditure has not quite doubled, and the Government now obtains a net revenue of Rs. 7,50,000 from a department which was not remunerative twenty years ago.

Will the forest revenue continue to expand in future, if so at what rate; and what should be the eventual annual yield in hard cash of the State forests?

The area of the forests under the direct control of the Department, *i.e.*, reserved forests, reserved lands and topes, amounted to 19,657 square miles on the 30th June 1902, and as the work of selection of areas for reservation is approaching completion, no great increase in area is probable, and the ultimate forest area may be put down as 20,000 square miles.

The unreserved and unoccupied area exceeds 51,000 square miles, but this includes all land not shown as occupied in the village registers; river beds, tank beds, roads, village-sites, lands

liable to spasmodic cultivation at intervals of a few years, swamps, marshes, sand dunes, etc., as well as unreserved forest areas are clubbed together under this one head in the annual returns, and it is impossible to say what is the actual area of unreserved forest over which the Department exercises a limited control, and from which it derives revenue; equally impossible is it to discover how much forest revenue is derived from unreserved lands, though it undoubtedly amounts to a large sum in several districts in which the produce of fruit trees, the bark of the tangedu (*Cassia auriculata*) and other minor products are sold annually by auction, in addition to which permits are issued for certain classes of trees and the value of all trees on lands taken up for cultivation helps to swell the miscellaneous forest revenue not derived from the areas under the special charge of the Department No calculations based on the gross forest revenue could be applied to the actual reserved area, and a statement that the yield of the State forests $= \frac{250,000}{10,000} =$ Rs. 125 per square mile would be far from correct. We must therefore turn to the forests themselves and endeavour to show what would be the value of their yield if they were properly protected and markets could be found for their annual yield. To arrive at anything like a correct figure, the forests would have to be divided into classes, the annual yield in material of each class being treated separately. The bare and burnt hills of parts of Cuddapah and Kurnool, the sal forests of Ganjam, the casuarina plantations of the East Coast, the sandal wood areas of Coimbatore and the dense forests of the heavily watered Western Ghats present such absolutely different types that any attempt to generalise must give incorrect results. Sir Dietrich Brandis, after inspecting many of the forests of the Presidency, estimated the growth in the poorest of the poor forests of Cuddapah at one-fifth ton per acre per annum; the Nellore casuarina plantations yield from 40 to 60 tons at ten years of age, or, say, four tons per acre per annum; the luxuriant growth of the Western Ghats must average quite one ton, and the great value of sandal wood places it in a class by itself, while bamboos with their rapid reproduction raise the average yield of many otherwise poor forests; but, on the other hand, petty thefts, organised thefts and fires sadly diminish the annual growth which Government can hope to sell or to store up for the improvement of its forest estate. This is concerned with the question of better protection, which will be dealt with later.

A very rough division of the State forests gives one-third unproductive, one-third productive and one-third remunerative; the actual unproductive area is probably less than one-third, but in generalising it is safer to under- than to over-estimate the sources of income. The productive area is principally deciduous forest yielding fuel and small timber, and the remunerative area includes casuarina plantations, sandal wood areas and high timber forests.

Under unproductive forests are included all the poorest forests, in which the annual growth is estimated at less than one-fourth ton per acre per annum; such areas are mostly very badly stocked and are burnt over annually; to improve them and convert them into productive forests would necessitate a long period of rigorous closure and fire-protection, aided in many instances by artificial reproduction. But absolute closure is impossible on account of the demand for pasturage for the cattle of neighbouring villages; this with the sale of thatching grass and possibly a small income from the sale of fuel is the only revenue which can be expected until these areas are re-afforested, and the average annual revenue may be put down at six pies per acre or Rs. 1,33,000 altogether.

In the productive forests the annual growth is not less than one-fourth ton per acre per annum, and taking this minimum as an average in order to err on the safe side, and further assuming that the gross value of the wood does not exceed Rs. 2 per ton (a very moderate estimate), the annual yield would amount to eight annas per acre or Rs. 21,33,000, to which must be added grazing at 6 pies per acre or Rs. 1,33,000, and minor produce at, say, 1 pie per acre or Rs. 22,000; in all Rs. 22,88,000.

In the remunerative forests the produce varies considerably; teak and rosewood are worth up to Rs. 160 per ton (gross), sandal wood realises as much as Rs. 450 to Rs. 500 per ton; the value of casuarina is much lower, but the yield per acre is considerable, and in none of the forests of this class would the gross annual yield be less than Rs. 5 per acre if all the timber could be brought to market; at present this is impossible owing to want of roads, timber slides, tramways, etc, but as this estimate is based on the assumption that in due course all such necessaries will exist, Rs. 5 per acre is taken as the average yield; this gives the rather astonishing figure of Rs. 2,13,33,000. This large figure only means after all that in a fully stocked timber forest, worked on a revolution of 120 years, each acre should, on attaining maturity, contain timber worth (gross) Rs. 600; a low estimate of the crop on such an area would be 30 trees of 2 feet diameter and 40 feet bole, which would yield over 3,000 feet of timber; the above estimate therefore works out to Rs. 0-3-2 per cubic feet, which it must be admitted is very low, especially as it represents the gross value of the wood at the nearest market.

Add now Rs. 1,33,000 for grazing, for although these forests are richer than the preceding classes they are not more suitable for grazing, and Rs. 1,33,000 for minor produce, as it is in these forests that the more valuable minor products are found, and the total gross revenue for the remunerative forests amounts to Rs. 2,16,00,000.

The total forest revenue for the Presidency from State forests only would then amount to *two hundred and forty lakhs* in round

figures, or almost ten times the present revenue, and if the existing ratio between revenue and expenditure were maintained, the net revenue would amount to no less than eighty lakhs.

Although the revenue producing power of forests is the lowest imaginable point of view from which a Forest Officer should regard them, it is permissible to descend to this level on behalf of the forests themselves, and as they can only be made to yield their full revenue if efficiently protected, it may be well to show what, under such circumstances, might be expected from them.

In a subsequent article the question of the establishment necessary for the efficient protection, management and regeneration of the State forests will be dealt with.

TSEROFSHI.

Forestry in America.

By H. J.

(*Continued from page* 401.)

Chapter VII.—Sylviculture.

The whole forestry business turns upon sylviculture, and the chief obligation of the forester is to replace the crop he has harvested by as good, if not a better, crop of timber than he found.

Generally restricted to the poorer soils and conditions, he is forced to the most conservative management of the natural resources, because so long-maturing a crop cannot repay much expenditure.

The simplest method of harvesting a crop is to clear the ground by a clean felling, and then to plant or sow the new crop. In some cases the regeneration may be effected naturally by seeds falling from the trees of the old crop, and the forester will then merely direct operations so as to favour the reproduction of the more desired kinds. When left to nature, the exposure of the soil, the danger of fires, and the probability that the least desirable species will predominate in the new crop are serious drawbacks.

This method is best suited to pure crops of light-demanding species. The working is concentrated on a small area, and the transport of timber and produce is cheap. It is of course not suited to forests of protection or of ornament.

Next comes the selection method, the crudest and least intensive method, in which all ages and sizes are mixed together over the whole area, coming nearest to the conditions of nature.

In Germany the thinnings yield 25 per cent. or more of the final total yield.

The preservation of the soil moisture, and the soil cover free of weeds and grass, is always an important consideration in these operations.

The entire sylvicultural requirements of the crop resolve themselves thus into one, namely, the proper management of light conditions, secured by the judicious use of the axe.

The forester has discovered that mixed crops, although requiring more skill in their management, and including species of inferior utility, give not only better results in quality and quantity, but also give better protection of soil conditions, and especially safety against many dangers, such as insects, frosts, storms, etc.

A dense crop of *mixed species in vigorous development*, with no dead or dying trees, or débris lying about, is very safe as a rule from insect attacks. Protection from wind is best secured by keeping the crop well thinned, and in locating the coupes so that they proceed in the direction opposite to that of the prevailing winds.

The greatest danger to forest properties however is *fire*. In most cases it is confined to the forest floor, merely scorching the older trees; yet sometimes the fire may run up the trees and propagate itself from top to top, often for long distances.

Young crops are readily killed, especially in coniferous forests, with their dry resinous foliage and wood, and dry soil. Up till the pole stage, the damage usually consists *in the total* loss of the crop, and what is even more important, the loss of the soil cover and litter, the forest's manure.

In parts of the forest which have been heavily worked, and where the amount of débris, branches, and other waste is great, the fire risk is very serious, and continues for many years, especially in coniferous woods.

Forestry is in fact throughout the United States only possible in places where the whole yield, including the inferior material and fuel, are utilizable: otherwise the risks from fire are too great, or else the cost of clearing the ground for the young crop will be too large.

That the fire danger may by *proper measures be effectively* reduced to a minimum, is shown by the statistics of German forest administration. In Prussia and Bavaria, the average area burnt within the last 25 years rarely exceeded ·005 per cent.; and in India, under much more difficult circumstances, not more than about 8 per cent. of the protected areas has experienced damage. Some simple preventive measures, apart from police regulations, may be mentioned here.

Woods of deciduous species, being less liable to danger, indicate the advisability of the maintenance of mixed crops: the fact that old timber is safer than young, and that, on large wind-swept areas the heat and rapidity of the fire is increased, leads to distributing the coupes and keeping thereby the younger parts of the crop in small areas surrounded by older timber. The removal of the dead and dying trees in thinnings, and the disposal of the refuse of slabs, tops, branches, and chips from conversions in the forest are obvious means of reducing the danger.

CHAPTER VIII.—FOREST ECONOMY.

In forestry, as in other technical industries, the technical art, that is, sylviculture, is distinct from the business conduct, that is, forest economy.

Beside the technical care in managing the productive forces of nature to secure the highest gross yield, there must also be exercised a business management to secure the most favourable relations of income and expenditure, that is, the highest net yield; and lastly a systematic order in working to produce this revenue is necessary.

In some Government forests, the money profits may be of comparatively little or no importance, compared with other benefits derived from the forests, but even in such cases it is still desirable to organize the working systematically so as to bring into relation results and efforts, that is, to count the cost.

The time element is the one peculiarity which distinguishes forestry from every other business. The forester cannot, like the agriculturist, harvest annually the current increment, and the forest crop is only mature and useful when the accretions of many years (from 20 to 200) have been accumulated. Therefore, in forestry, when practised as an independent industry, as in any large business establishment, it is desirable to organize and manage the business so as to secure continuously and systematically a regular annual income nearly equal or increasing year by year.

The forester's business is thus based upon the conception of the "sustained yield", and it is by means of forest regulation. or working-plans, that the realization for ever of an equal annual revenue derived from the annual production of wood crops in the most profitable form is secured.

The standard of conduct and condition which the forester aims at attaining—tries at any rate to approach, so far as is practicable—is the *normal* forest, which is an ideal forest in such condition that it is possible to harvest annually for ever the best attainable product, or to secure continuously the largest possible revenue.

In this normal forest, there must be as many equal crops, varying in age by years, as there are years in the exploitable age; that is, *normal* age-classes must be present, so that an annually equal *normal* yield may be harvested, while the reproduction is looked after and the best possible production, the normal annual increment, is secured by sylviculture.

Under these conditions, the normal stock would be present, permitting the desired annual sustained yield management.

We have seen that this normal stock, varying of course in amount according to species, site, sylvicultural system, and especially length of revolution, is found by summing the arithmetical progression represented by the accumulated increments of the age-classes, and is equal to half the accretion taking place throughout the revolution over the whole area, the other half furnishing the yield during this same lapse of years.

It is not necessary of course that the age-classes, the crops of different ages, should occupy so many separate areas; they may be all mixed up as in the selection-worked forest; in such a case, the normal condition is attained when there are enough trees in gradation from the older to the younger, allowing for losses for the younger age-class, to replace in amount the older as it is removed or grows out of its class.

In real life the actual forest will always for one reason or another be abnormal.

The normal increment may be deficient, because the area is not fully stocked, or the timber is past its prime; the age-classes too are never present in exactly the proper gradation and amount; some will be probably entirely absent, and others may be in excess, so that even if the normal stock of wood be on hand in amount, it may be abnormal in distribution.

The normal increment or annual production can only be established by sylvicultural methods, and the other two conditions (amount and distribution of the age-classes) are obtained by regulating the yield in area and amount, so that gradually the age-classes and the normal stock are established. Various methods are employed to determine the actual yield, which will gradually lead to the ultimate normal possibility.

The simplest way would be to divide the forest into as many equal areas as there are years in the revolution, and to cut one each year. But this burdens the present generation with the entire cost of securing the normal state, and probably entails a very fluctuating yield, together with a financial loss, resulting from the fact that over-mature and immature crops will be felled.

To obviate these disadvantages, the "allotment method" was invented, in which the yield is only fixed for a short rotation of ten years, and both the areas and the volumes of the present

fellings are modified according to the existing state of the crops in different parts of the forest.

The most logical, though often not the most practicable, way of fixing the yield is by adding or deducting from the normal annual increment the difference between the normal stock and the actual stock, divided by the number of years in a conveniently chosen period of equalization.

In every case, the owner's interest must be the guiding principle in the management of any property, and it must be remembered that financially forestry means the foregoing of present revenue, or the incurring of present expenditure, for the sake of future revenue; it involves gauging present and future advantages, and the time element is the prominent feature of its finance calculations.

In making a working-plan, the first thing required is a topographical forest survey, followed by a quantitative survey, by which, in addition to a stock-taking, the local rates of growth and the average age of maturity will be ascertained. If normal yield tables exist, the annual yield can be at once determined by comparing the actual local conditions of growth, and the state of the crops, as described at length in the valuation survey, with these tables, which are the result of measurements of the most perfect normally stocked crops of various species, and give the average contents of such crops in ten-year periods under normal conditions per unit of area.

The next most important question to be solved is the age, or sizes, to which it is desirable to let the trees grow before felling them.

There is no natural maturity of a forest crop as we know it in agricultural crops; wood does not ripen naturally, nor do trees even die at a given period, but gradually decay. The proper felling age must therefore be generally determined by economic considerations.

Although the forester bases his calculations partly at least on the size of his crop, a simple girth or diameter limit, below which every tree is to be considered immature, would be unsound, because, without attention to systematic reproduction and cultural operations to favour the more valuable species, and to keep under the least desired kinds, the diameter restriction is of little value.

The determination of the exploitable size or age is largely a matter of financial calculation, influenced by sylvicultural and technical considerations.

For instance, the age up to which trees coppice or the periodicity of seed-years may have to be taken into account, as well as the technical value of the product and the market requirements for special materials, such as railway sleepers, etc.

From the standpoint of political economy, it was first supposed that the largest volume of produce per acre per annum ("absolute exploitability") should be the aim of forest management; but it can be shown that this age occurs quite early in the life of the tree before it has attained a useful size.

Since the current increment of a crop gradually increases in rate from its early stages up to a given age and then again sinks, there must be a time when the average accretion, the mean annual increment, attains its maximum. If, for instance, a fully-stocked acre of spruce contains at 120 years 10,200 cubic feet of wood, its average annual production is $\frac{10200}{120}$ =85 cubic feet, and if a crop aged 80 years contained 6,880 cubic feet, its average annual production was $\frac{6880}{80}$ =86 cubic feet; hence from the standpoint of volume production a rotation of 80 years would be preferable.

It is, however, evident that value production is generally more important than volume production, so that if in the above instance the price averaged for 80-year old wood of all sizes was 3 cents per cubic foot, and 4 cents for the 120-year old wood, then the average value increment would be in the first case $2·58, and in the latter $3·40 per annum, so the longer rotation would be the more favourable.

But even the exploitability of the maximum value production will not satisfy any private investor, since it leaves out of consideration the expenditure necessary to secure this result.

The annual expenses should at least be deducted, and as these vary with the length of the rotation, that age should be found at which the surplus of the annual revenue over the annual expenditure is greatest, the rotation of the highest forest income. Finally, even this last age of exploitability will not be financially sound, since it takes no account of the capital invested, nor of the interest accumulating with the time.

The true financial exploitability corresponds, therefore, to the rotation which brings in the highest rate of interest on all the capital invested in soil and stock of wood,—that is, the rotation of the *highest soil rent.*

We have thus to calculate whether the saving made by lengthening a rotation will be profitable or not, and here we have to do with forest finance, a branch of forest economy which concerns itself not only with finding the present value of a single crop, and with the future value to which it is growing, but also with its value as a part of a regulated forest management, in which it is for all time to come an inherent necessary member as a producer of values.

The time element, the foremost peculiarity of forest economy, here comes most prominently to expression.

The inability of withdrawing annually the interest on the invested capital makes compound interest calculations necessary, and as this compounding has to go on for a long number of years, and the investment is—perhaps with the exception of the danger

from fire,—safe, easily managed, and requiring little labour, the rate of interest at which the compounding is to be calculated is necessarily low, and should not exceed 3 or at most $3\frac{1}{2}$ per cent.

The soil expectancy value is calculated from the present capital value of the intermittent revenues yielded by the final felling, and the intermediary fellings or thinnings, minus any original outlay for planting, etc., also calculated up to the end of the rotation; and from this present capital value so calculated, the capital required to furnish yearly for ever the annual charges for administration is deducted.

This calculation is, however, often difficult to make practically, owing to the uncertainty of the values to be given to the various items and of the future rate of interest, so that in practice the simpler forest rent calculation is often more satisfactory.

In selection-worked forests, instead of calculating the yield for the whole revolution, it is sufficient to base the calculation only on the existing number of mature trees, and the time required for the present stock of second class trees to grow up to the exploitable size. This method is not used by the American Bureau of Forestry, which, instead, ascertains and compares merely volume production by constructing a yield table. This method is, however, used by the Indian Forest Department, as paving the way for better methods, but caution is necessary in its application, as it is based upon the assumption, probably not often correct, that reproduction will take place, and that the younger age-classes exist in sufficient amount to take the place of the older.

A closer approach to true financial calculation could be made by basing the exploitable size on the highest net value per unit of volume in connection with the time it takes to replace it. It is evident that the value of the unit volume increases with the size of the log, yet in a decreasing ratio, so that if the time required to produce the cubic foot is put in relation, the most profitable exploitable size can be found.

A further improvement, securing a more sustained yield, requires that the number of dominant trees of the different size classes be ascertained, and compared with the number which should exist in the normal fully-stocked forest, and then the required number left of each class, or the excess removed, to bring the number to the standard.

The approach to the normal condition can, in any case, only be gradual, and may be secured in a longer or shorter time, depending on the owner's interest; in other words, the regulation of the working, primarily based on mathematical measurements of increment, yield, and values of produce, must in practice be modified by judgment, to allow for changing conditions.

Sylviculture, the replacement of the crop, is always the more important obligation, assuring continuity of yield, which can often be practised without any elaborate organization of the ideal business conduct.

Fungus Destructive to Deodar.

By B. O. COVENTRY, F.C.H.

ON 1st May 1903 at Konain, Jaunsar, U. P., I found a deodar tree blown down by the wind whose roots were absolutely rotten, with the exception of one side root which still appeared sound. The crown was still green and fresh, so the tree had only quite recently been blown down, and appeared perfectly healthy, being well developed and with a vigorous leading shoot. The tree measured 55½ feet in length and 2½ feet in girth. It was on the edge of a group of poles and had ample light. The roots were absolutely rotten throughout, with the one exception, the rotten wood being of a red-brown colour. The rottenness did not extend to the wood above ground as far as could be seen, although on one side of the stem underneath the bark to a height of six inches above ground the mycelium of a fungus was found which had destroyed the cambium tissues at this part. Just below ground underneath the bark the mycelium was thick and felt-like; elsewhere it was generally thin, like paper, or ramifying as threads under the bark, while mycelium was also present between the different layers of bark. In some parts the mycelium was of a purplish colour. A fair amount of resin had exuded from the stem where the cambium had been destroyed, but was only visible on removing the bark. There were no visible signs above ground of anything wrong with the tree, and had the tree not been blown over, exposing the rotten roots, no damage would have been suspected, and yet if the tree had not been blown down it could not have lived more than one or two years longer at most. The tree had been growing in contact with an old

FIG. 1.—Sporophores of a fungus on deodar: *a*, Bark removed showing the white mycelium; *b*, Bark partially scraped off showing white mycelium under bark flakes; *c*, sporophore (dotted line represents ground surface).

deodar stump of considerable age, which was rotten below *ground, and it appeared as if the fungus had extended from* this old stump to the living tree. I could not detect any signs of a sporophore, but thought that perhaps the thick felt-like portion of mycelium might be the early stages of one. Not far from this spot, about twenty yards off, there was a group of about six deodar poles dead, three of which were standing; the others had been cut and removed for fuel, only their stumps remaining. The roots of these trees were rotten. I noticed white hyphal threads, white mycelium in the bark and white mycelium underneath bark. One of the trees measured 3ft. 6in. in girth. There was no apparent explanation for the death of the trees unless it could be attributed to a fungus. They had plenty of light and the locality was in every way suitable as far as could be seen.

On 17th May at Koti Kanasar another group of four or five dead deodar poles was seen, and at the bases of two of these sporophores were found. The accompanying photographs show these sporophores. On the larger tree the sporophore was a thick brown incrustation with white hymeneal layer at the base of the tree close to the ground. Underneath the bark there is a sheet of thin white mycelium, like tissue-paper, clearly seen in Fig. 1 at *a*. The girth of this tree was 20 inches.

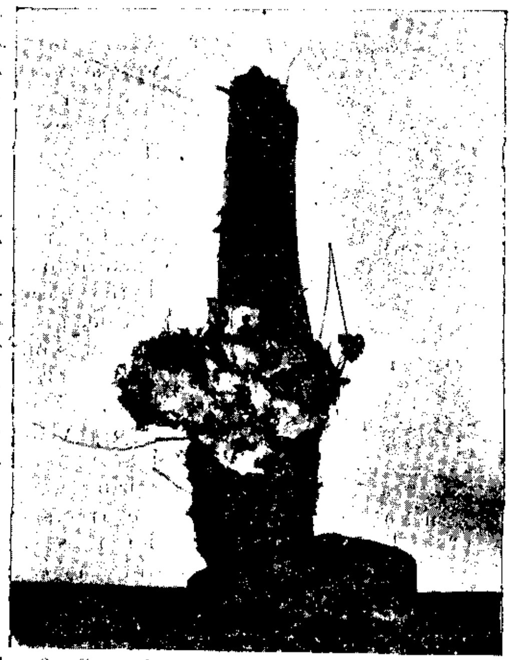


FIG. 2.—Sporophores of a fungus upon deodar, Showing bracket-like structures above ground.

On the smaller tree there was a thick rusty brown incrustation on the main root just below ground, over part of the surface of which pores (apparently hymeneal layer) were present. Extending above ground, the rusty brown incrustation merged into a number of small bracket-like structures with white under surface and a rusty brown margin; the upper surface of the small bracket portions being lighter brown in colour and marked with concentric ring-like zones of growth. The roots of both these trees were rotten.

Although it is impossible to say for certain whether the fungus whose sporophores were found on the dead deodar poles was the cause of their death, yet from the fact that there appeared to be no other apparent cause, and that only shortly before a healthy living tree had been discovered with its roots attacked and destroyed by a fungus, there seem to be strong grounds for considering that these young poles were killed by the fungus. The fungus seems to be one which spreads from tree to tree attacking the roots, as in two cases groups of dead poles have been found. As far as the green tree is concerned, there is no doubt whatever that the tree was attacked when in a healthy condition, and would undoubtedly very soon have succumbed under the attack of the fungus had it not been blown down. Whether the sporophores found on the dead poles belong to the same species which attacked the green tree cannot yet be stated.

I am sending this note in hopes that other Forest Officers in deodar tracts will keep a look-out and see if they can throw further light on the subject. Specimens are being sent to Dr. Butler, Cryptogamist Botanist to the Government of India, and it is to be hoped that he will be able to give further information.*

Botany and the Forest Officer.

By Sir W. T. Thiselton-Dyer, K.C.M.G., F.R.S.

In a sympathetic notice in the *Indian Forester* of the late distinguished Inspector-General of Forests in India, Mr. H. C. Hill, Sir Dietrich Brandis stigmatises as "absurd" "the idea which, until a short time ago, was current in England, and which to this day is held by many English botanists, that a good botanist must necessarily be a good forester." I quite agree that the idea is absurd, but as I am probably better acquainted with the English botanical world than Sir Dietrich Brandis I doubt very much whether the idea was ever current in this country or is held at the moment by many English botanists. For my part I entirely dissociate myself from it, as I know many accomplished botanists who would probably make very indifferent Forest Officers.

I am more able to agree with Sir Dietrich Brandis when he says:—"A forester, more than almost anybody else, must use his eyes and must be able on the spot to draw conclusions from

* A report by Dr. Butler on this subject will shortly appear in the Appendix series of this Magazine.—Hon. Ed.

what he has observed." But the power of observation is by no means possessed by everyone. A further requisite, in which I think Sir Dietrich Brandis also agrees, is sympathy with and pleasure in Forest nature for its own sake. It appears to me that neither point is kept in view in the present mode of recruiting the Indian Forest Service.

Sir Dietrich Brandis lays great stress on sport, and unless it becomes too absorbing a pursuit it undoubtedly fulfils the conditions I have stated. It would, however, be as undesirable to insist that every Forest Officer should be a sportsman as that he should be a botanist.

But I entertain a very strong opinion that a Forest Officer will never rise to the highest level of efficiency in his work unless he has a scientific grasp of the principles which underlie it. He should be able to identify the trees which compose the forest-vegetation under his charge, and for this purpose he should have such an elementary acquaintance with botany as will enable him to use intelligently the book which Sir Dietrich Brandis has been for several years occupied at Kew in preparing for the purpose. He should further have some knowledge of the nature and conditions of vegetable life: he should grasp the idea that a tree is a living organism whose growth and development are subject to adverse or favourable conditions. He should further have some idea of the enemies and diseases by which trees are liable to be attacked and of how these attacks can be met. All this a man of ordinary intelligence can acquire if he possesses a real taste for nature without rising to the level of the professional botanist, which it would be absurd to demand of him.

There is the same fallacy underlying the view that mere administrative efficiency is sufficient for a good Forest Officer as in thinking that mere mechanical drill without resource or initiative will make a good soldier.

As I have felt it my duty to urge these views officially I should be glad to state them more publicly.

I should like to take the opportunity of expressing my regret at the untimely death of Mr. H. C. Hill, the late Inspector-General. Largely as the result of my personal persuasion he accepted a mission in 1900 to initiate a scientific forest administration in the Straits Settlements. His reports were of the highest value and will be a permanent basis for the future forest policy of that part of the Empire.

KEW, *August 25th*, 1903.

Shrinkage in Timber during Flotation.

I.

WITH reference to Mr. Tulloch's note in the *Indian Forester* for August regarding the shrinkage in timber during flotation, the following explanation, which will appear in the Punjab Annual Forest Report for the year 1902-03, will, I trust, make matters clear. There is an undoubted loss in volume in logs between the launching point and their receipt in sale depôts of about 16 per cent. How much of this is due to shrinkage of the timber and how much to wear and tear in the water it is not at present possible to say. Systematic measurements are now taken annually and reliable information should soon be forthcoming.

The measurements of logs at the launching points and of the same logs when received at the sale depôts were continued, and there are now five years' figures to help us in estimating the amount of loss incurred by a log in its transit from the forests to the sale depôts. These observations have been taken on the Jhelum, Ravi, Chenab and Sutlej rivers, and show that a loss of at least 16 per cent. undoubtedly occurs. The logs, it is to be remembered, often take two or three, or sometimes many years to reach the depôts, during which time they are frequently stranded and exposed to the sun. They have also to pass through many rough places, and the loss is probably as much due to wear and tear in the water as it is to actual shrinkage of the timber. Further observations are required to set this point at rest.

A statement was made in para 41 of last year's report that enquiries made in Bashahr tended to show that "for every 100 cubic feet cut in the forest and exported in the log, not more than 72 cubic feet are received in depôts, some 19 per cent. of the loss being attributed to shrinkage. Whilst for every 100 cubic feet cut and exported in scantling it is calculated that 48·5 cubic feet reach the sale depôts."

This statement has attracted considerable attention, and not being as clearly expressed as it should have been requires further explanation. By measurements made during the last five years it has been found that for every 100 cubic feet of log measured where it has been felled in the forest, 91 cubic feet reach the launching point, 9 cubic feet being lost on the way from the forest to the river. This is chiefly due to the loss of the bark, which gets knocked off in transit. Of the 91 cubic feet launched in the log, there will be a loss of about 16 per cent. or 14·5 cubic feet on account of shrinkage and general wear and tear in the water; and 5 or 6 per cent. on account of breakages and thefts in transit. Not more therefore than 72 cubic feet in every 100

cubic feet cut in the forest and brought out in the log reach the sale depôts.

For every 100 cubic feet of timber cut and sawn up not more than 52 cubic feet of scantlings will be obtained, *i. e.*, there is a loss in conversion of 48 per cent. Of these 52 cubic feet 5 per cent. may be lost in transit, so that not more than 49 cubic feet of scantling out of every 100 cubic feet cut in the round can be expected to reach the sale depôts.

No deduction is made for shrinkage in the case of scantlings which do not contain sapwood, as is the case with logs. These are, moreover, usually cut slightly larger than the standard sizes to allow for shrinkage, wear and tear, and the loss on this account is included in the loss by conversion.

F. BEADON BRYANT,
Conservator of Forests, Punjab.

II.

IN the August number of the *Forester* there is a letter from Mr. J. C. Tulloch on this subject, in which he quotes figures with reference to the Bashahr Division. The loss of 19 per cent. in the volume of the logs, which is termed shrinkage in the Punjab Circle Report for 1901-02, includes all breakage and general wear and tear between the time the logs are launched and the time they are received in the sale depôt. But Mr. Tulloch is not quite right in assuming that during this time the timber lies in the water. The average time occupied by a log in transit on the Sutlej River may be safely taken to be not less than one year, and for most of this period the log is either stranded on rocks in the upper part of the river or in the *chhandas* in the plains section, or is lying in one or other of the transit depôts. In all these cases the timber is seasoning, and surely this means shrinkage. I am not prepared to uphold this term as the best that could be selected to include all the forms of loss to which the timber is subject; but I think there can be no question that much of the total loss is due to true shrinkage in contents.

The figures quoted show a total loss of 28 per cent. between the forest and depôt measurements of the logs; 9 per cent. between the forest and the launching point and the 19 per cent. under discussion. The 9 per cent. is due to the removal of bark and general damage in the passage of the logs down the slides to the river bank. These calculations were based on the figures for the last twenty years, and presuppose the opening and closing transit balances in the river to be identical. To generalize in this manner is, perhaps, of less value

than to take the figures for logs carefully measured before launching and re-measured in the sale depôt after identification by their marks. Figures obtained in this way, in the case of 586 logs during 1902, show a total decrease of volume in transit of 10·8 per cent.

The 51·5 per cent. of loss in the case of scantlings was intended, obviously, to show the loss between the forest measurements of logs and the contents of the resulting scantlings received in the sale depôt. Loss of scantlings in transit to this extent is not conceivable even in the worst of rivers, and for power to reduce timber to matchwood the upper part of the Sutlej is hard to beat. In the figures Mr. Tulloch gives to illustrate the loss of scantlings in Jaunsar, he does not state how he treats broken scantlings or balances known to be in transit at the commencement and close of the 13-year period he refers to—points which are of considerable importance. In Bashahr on the Sutlej the figures for the eleven years ending 1902-03 are as follows:—

		No.	c. ft.
Launched	... ...	274,415	905,591
Received whole	... ...	234,555	720,452
Ditto fragments	...	29,744	43,402
In transit on 30-6-03	...	11,364	31,163

Very few scantlings were launched in the year immediately preceding 1892-93, and so the transit balance at the commencement of the period is assumed to be *nil*. The figures show that if each payment is taken at one half of a whole scantling, the loss is 5 per cent. in number and 12·2 per cent. in contents. The figures for the year 1902-03 with known transit balances are 2·3 per cent. in number and 10·2 per cent. in contents.

G. S. Hart,
Deputy Conservator of Forests,
Bashahr Division.

A Note from the Myodwin Teak Plantations.

I AM sending you a photograph of a view taken in the 1868 teak plantations of Myodwin, Tharrawaddy Division, and also one of some ruins which are, I believe, the remnants of the bungalow occupied by Forest Officers and Sir Dietrich Brandis in the early seventies.

I have always understood that Myodwin was at that time the headquarters of the Forest Department in Burma, but 20 years ago I could only find a few houseposts left. Myodwin is now a

small village some seven miles from the railway and fairly accessible, but in the old days I understand it took about three weeks to procure stores from Rangoon by cart.

It would interest many besides myself if Sir Dietrich would, through your journal, give a short description of the Myodwin of his day, and explain why this apparently inaccessible jungle village was selected as a site for a headquarters station. This has always puzzled us. Myodwin may be translated the "city well" or the "well of the city," but there are no remnants of any "city" to be found now.

To my mind there is something very pathetic about these two views. On the one hand, the ruins of a home which once echoed to the gay laughter of many of our predecessors, some of whom are gone and forgotten; on the other hand, those grand young teak trees in all the vigour of their youth putting forth an annually increasing wealth of foliage and asking only to be let alone to fulfil the destiny for which they were brought into existence by the former inhabitants of that house in the corner of which but the ruins now remain.

H. S.

The Assam Manual on the Powers of Forest Officers to Compound Offences.

WOULD you kindly oblige me with an opinion as to the meaning of the last clause in the paragraph quoted below.

It seems to me that officers drawing Rs. 100 or more are empowered under section 62 of the Regulation to compound. I believe certain officers of this rank in the Central Provinces do compound.

I contend that the clause has been so worded for the purpose of permitting such officers to do so. *Vide* section 62 (3) of the Regulation.

There is however a difference of opinion on this point, and an interpretation *ex cathedra* is solicited.

THE ASSAM FOREST MANUAL.

Page 42, Rule 11. The Chief Forest Officer of the Province, all Deputy Conservators, Assistant Conservators, Extra Deputy Conservators and Extra-Assistant Conservators when in charge of Divisions or Forest Districts, and all Deputy Commissioners and Subdivisional Officers shall exercise powers under sections 34, 36, 43, 44, 45, 47, 57, and 76 and also the powers referred to in clause (1) of section 68 of the Assam Forest Regulation. If the officer draws a monthly salary of Rs. 100 or more, he shall also exercise powers under section 62 of the Regulation. R. O.

[We have read the sections in the Assam Forest Manual referred to and have submitted R. O.'s question to several experts in the matter. The consensus of opinion is that the wording of the clause in question could with advantage be improved. There can be little doubt that the intention and spirit of the rule is that all Officers-in-Charge of Divisions shall have the power to compound offences, provided their monthly salary is Rs. 100 or more. It has probably occurred at times that the Province has been short-handed in Officers, with the result that a Forest Ranger has held charge of a Division. Hence the necessity for the rule. R. O.'s contention that all Officers drawing Rs 100 and above can compound offences cannot hold water. If this were so every newly joined Assistant Conservator would have power to compound, in other words he would be empowered by Government to carry out acts which it would be out of his power to do justly, since until he had learnt the language he would be totally in the hands of subordinates, who through him would use this power to their own ends. We understand that in the Central Provinces certain Officers not in charge of divisions but drawing pay of not less than Rs. 100 per mensem are by special notification giving their names, granted power to compound, subject to the confirmation in each case of the Divisional Officer.—HON. ED.]

Cordite Rifles in the Indian Forests.

HAVING during the course of carrying out my professional duties considerable opportunities for *shikar*, I should deem it a favour if Forest Officers would obligingly give me, through the medium of the pages of the *Indian Forester*, their opinions, based on *actual practical experience*, of cordite rifles for heavy

game. Is a ·450 cordite rifle heavy enough to stop a charging bison? Shooting on foot in thick bamboo jungle one often has little opportunity of choosing vital spots to aim at. It is usually a snapshot. As this snapshot may only be obtained at the end of a long tiring day's tracking, one naturally wishes to be armed with a weapon which will "stop" the animal if hit, whilst at the same time, as the rifle has to be carried by oneself for many miles, its weight becomes a question of maximum importance. I should be glad of advice from sporting Forest Officers on this matter.

BIG GAME.

The Government of India on the Madras Forest Administration Report of 1901-02.

In their review of the previous year's report, the Government of India had occasion to remark on the large number of forest offences that had been reported and on their continuous increase during recent years. There has been a further increase in the past year, and the administration of the penal provisions of the Forest law calls for serious consideration. It is possible that were greater attention given to the recruitment of the protective staff, which is described as being inferior both in number and character, fewer opportunities would be afforded for the commission of offences.

It is noted with satisfaction that while 332 square miles were added to the area under special protection from fire, the area burnt was only 65 square miles in excess of that of last year; and there is no reason why a still greater measure of success should not be attained in future. In the Central Circle, for instance, in no less than 26 cases did fires cross the exterior traces, with the result that an area of 14,600 acres of valuable forest was burnt; while in the Madura Division of the Southern Circle the large number of 21 fires occurred through accident or carelessness during the burning of fire-lines. These results indicate both insufficient protective measures and a want of supervision on the part of the Forest staff, and the Government of India trust that orders will be issued to prevent similar failure in future in the protective system.

The net profits of the working of the year are the largest on record, and the Madras Government are to be congratulated on these excellent results, for which, however, the Northern and Central Circles alone appear to have been responsible. It is to be regretted that the financial position of the Southern Circle is even worse than it was in 1900-01, a surplus of Rs. 53,000 having given place to a deficit of Rs. 37,000, while the number of Divisions in which the charges have exceeded the receipts has risen from 4 to 5, out of a total of 8. In the review of last year's report it was pointed out that the Forest Administration was here not entirely satisfactory, and the suggestion there made as to the possibility of developing more profitable markets for forest produce in this Circle will no doubt receive attention.

The length of the report has been much curtailed without any diminution of its value as a record of the year's work—an improvement which the Government of India cordially recognize. They would be glad if in future it were found possible to arrange for the more punctual despatch of the report.

Progress Report of the Forest Administration in Coorg, 1901-02.

THE changes which have taken place during the year in the area of the reserved and protected forests are shown in the following statement:—

Class of Forests.	Area on 1st July 1901.	Added during the year.	Excluded during the year.	Area on 30th June 1902.	REMARKS.
	Acres.	Acres.	Acres	Acres.	
Reserved Forests ...	1,52,407	...	...	1,52,407 (a)	(a) Consists of 1,68,636 acres of ghats only and 2,521 acres formerly paisari protected forests.
Reserved Lands (under section 4) Protected Forests.	...	1,71,157	...	1,71,157	
Ghat Forests	2,31,049	...	1,68,636	62,413	
Paisaris	1,74,755	...	1,74,755	...	
Urudves	3,107	...	...	3,107	
Devarakadus	15,506	...	...	15,506	
Total ...	5,76,824	1,71,157	3,43,391	4,04,590	

There was no extension of reserved forests during the year, but an area of 171,157, acres was notified under section 4 of the Act for reservation. Of this quantity 168,636 acres was formerly protected ghât forests; the area now standing under the latter head in the above table has consequently been reduced by that figure.

A Forest Settlement Officer has been at work since the beginning of July 1901. In all seven blocks of 2,521 acres on the plateau and three blocks of 168,636 acres of ghât forest were notified for reservation under section 4 during the year. In respect of the former, the whole settlement enquiry was completed and final orders were issued before the 30th June 1902. In respect of the latter three blocks the final draft notifications under section 19 were submitted to the Chief Commissioner by that date.

The reservation of the ghât forests and of the more valuable *paisaris* will, it is believed, be completed at an early date. The record of enquiry into *Deverakadus* and *Urudves* has been completed in two taluks and has made considerable progress in the remaining three taluks. The demarcation of *jama* cardamom *malles* and the question of allowing ryots in certain specified localities to continue the practice of cultivating by the *kumri* method are under

consideration, a joint report on the subject having been submitted to the Deputy Conservator and Forest Settlement Officer.

Pending final reservation no new lines were cut during the year in connection with the new reservations. About 22 miles of ghât boundary lines were cut between Coorg and Malabar to a width of 25 feet. The total expenditure on demarcation during the year was Rs. 555.

The preparation of a working-plan for the Janikal forests was commenced during the year. As regards the sandal Plan the prevalence and spread of the "spike" disease is so great that the whole data bearing on the plan are said to have been disorganized and the preparation of the same must be postponed pending the result of the remedial measures now being put into force.

On the important question of communications and buildings the Deputy Conservator writes that with the exception of the ghât forests, still under settlement, the Division is completely provided in this respect—a most enviable state of affairs.

There is a further decrease of 28 in the number of reported cases of breaches of the Forest laws during the year, the number having thus fallen from 106 in 1899-1900 to 59. The fall is attributed to a return of prosperous seasons.

The Chief Commissioner appears to attach considerable inportance to the continuance on a large scale of the work of eradicating the lantana weed.

The results of fire conservancy were extremely satisfactory, and the whole credit for this position of affairs appears to be due to the initiation by the Deputy Conservator of a system of employing the whole *kurubar* population of the forests, including the foreign settlements on the Mysore border, on a system of rewards according to results. There were in all five fires covering 170 acres against 12 fires and 1,483 acres last year. This is the best season on record. The cost of fire protection was less by Rs.326 than last season.

There is a remarkable decrease in cattle grazing on payment, an explanation of which is expected in a report shortly to be furnished by the Deputy Conservator.

The return to normal seasons and the practical absence of forest fires has resulted in favourable growing conditions, and the reproduction of teak and particularly of "honné" (*Pterocarpus marsupium*) and "beti" (*Dalbergia latifolia*) is said to be very satisfactory.

The same remark cannot, however, be applied to the sandal, the Deputy Conservator reporting that there has been no diminution in the disastrous ravages of the "spike" disease in naturally grown sandal. "As was mentioned last year, an attempt was made to check the spread of this disease at the Harangi river by the extraction of diseased individuals. It seems, however, that the disease is capable of infecting trees otherwise than through their own species. A total number of 20,000 infected trees and plants of all ages was extracted in the tract north of the river. The work was systematically taken in hand *villagewar* by parties in the charge of responsible Deputy Rangers and Foresters, and from personal and careful inspection of several localities, I am satisfied that the work was reliably carried out, but it is disappointing that on re-inspection at a later period fresh trees in considerable quantities were found to be attacked. The above area has already been twice gone over, yet the disease is constantly reappearing. Frequent observation has proved that the period from the first appearance to the death of a large tree runs from 9 to 12 months."

This spike disease still appears to be shrouded in mystery, as neither Dr. Butler nor Mr. Barber have been as yet able to publish reports elucidating the source of the attack. Consequently methods of counteracting it have yet to be devised.

Under the present orders of the Inspector-General of Forests an extension of 30 acres per annum of sandal planting was commenced during the year, and the existing plantations selected for maintenance were carefully weeded. The total cost of sandal cultural operations was Rs. 581, the weeding costing Rs. 470.

During the year 209 tons of rough sandal wood were brought into the depôts, which were dressed into 201 tons of good wood end chips, making, with the balance on hand of these latter from last year of 108 tons, a total of 309 tons. In addition there were also 32 tons of rough wood on hand from last year. Of this quantity 204 tons were sold during the year and 13 tons were written off as dryage. The balance in hand at the close of the year was therefore 92 tons of good wood and chips and 32 tons of rough wood. The amount realized at the annual auction for 204 tons put up for sale was Rs. 90,379, *viz.* an average of Rs. 443 per ton. This is the highest rate obtained to date.

A total of 301,096 cubic feet of other timber and poles was removed by Government agency and purchasers, whilst 5,320 cubic feet were given in free grants. In addition 108,020 cubic feet of poles and 132,970 bamboos and reeds by Government agency and purchasers.

The following table compares the results of the year with that of the preceding year:—

Forest year.	Division.	Revenue.	EXPENDITURE.			Net results.
			A.—Conservancy and works.	B.—Establishments.	Total.	
1	2	3	4	5	6	7
		Rs.	Rs.	Rs.	Rs.	Rs.
1900-01 ...	Coorg.	1,43,919	28,267	43,620	71,887	+72,032
1901-02 ...	"	1,69,556	40,329	45,118	85,447	+84,109
Average for the 5 years ending 1900-01.	...	1,34,458	...	...	76,265	+58,203

The gross receipts were Rs.25,637 in excess, which is mainly due to the increase of Rs.25,700 under sandal wood. The total expenditure shows an increase of Rs.12,000 under "A.—Conservancy and works," which is mainly attributable to the cost of the Forest Settlement staff, *i.e.*, Rs. 11,000. Notwithstanding this latter additional expense and the large balance of sold but unpaid-for timber, the net surplus of the forest year was Rs. 84,109, which is the highest recorded.

The report we have reviewed above, whilst being short and compact, is of exceeding interest, and Mr. McCarthy is to be congratulated on his excellent management of so varied and highly interesting a division, not the least point of interest in which is the fact that it has produced one of those difficult and apparently unsolvable problems in Nature which at times crop up and defy the accumulated knowledge of Science to provide a solution or remedy. In the words of the Poet—

O Star-eyed Science! has thou wandered there,
To waft us home the message of despair?

The Fauna of British India.

The Fauna of British India, including Ceylon and Burma. Edited by W. T. Blanford, F.R.S. Hymenoptera—Vol. II.—Ants and Cuckoo-Wasps, by Lieutenant-Colonel C. T. Bingham. Taylor and Francis.

Dr. Blanford, and through him the Government of India, are to be congratulated on the steady issue of the volumes of the *Fauna.* It will be well understood that no exact regularity can be maintained, but the series of volumes already issued, which comprise the Mammals, Birds, Reptiles (including snakes), and Fish amongst the Vertebrates; the Moths, Hymenoptera Aculeata (Ants, Bees and Wasps) and a portion of the Rhynchota amongst the insects and the Arachnida are an important contribution to a knowledge of the fauna of the country. In an age when biology demands philosophical conclusions, these books play a prominent part, though they are, as a rule, purely technical. A species must be known and recognised before any accurate observation can be recorded about it, and therefore we must cheerfully labour as descriptive hodmen before that golden age arrives when the weary describer will be at rest, and remembered only as a writer of necessary muniments.

Colonel Bingham has made the Indian Hymenoptera, and more especially the Aculeata, which this second volume completes, a special study, and his book can therefore be received as authoritative. That peculiar little group the Cuckoo-Wasps are included and are illustrated by a very handsome plate, the work of Horace Knight.

It will doubtless interest Forest Officers to hear that Dr. Blanford has now entrusted Colonel Bingham with the volumes on the Indian Butterflies, and we feel confident that the work could not be in better hands, and shall look forward with great interest to the results of his labours. Colonel Bingham will be glad to receive at the British Museum (Natural History) collections and specimens of all, even the commonest, Indian butterflies, only stipulating that localities where taken, with elevation and if possible dates of collection, should be recorded against each specimen sent.

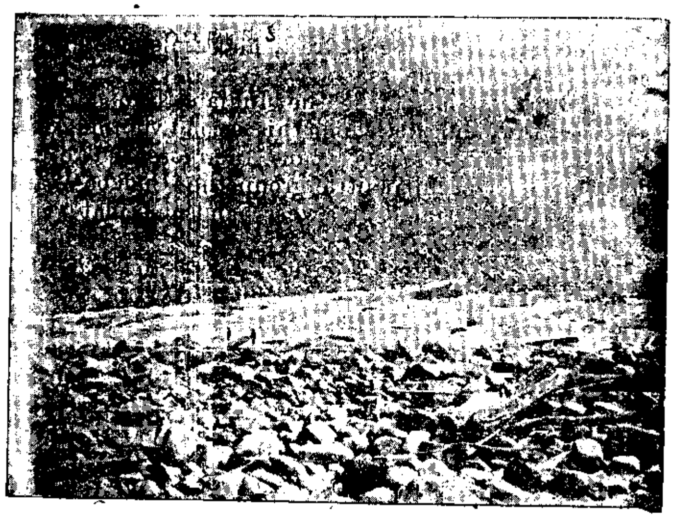
The Waterfalls of the Southern Shan States.

BY W. H. CRADDOCK.

THE Southern Shan States comprise a vast area of country which separates Burma proper from Siam and French Indo-China. They are made up of a number of States ruled by Chiefs with the advice of British Political Officers. Much has been written about the resources, climate and other matters relating to these States, and the Viceregal visit to the Northern

Shan States and the visit of the Shan Chiefs to the Delhi Durbar has had the effect of bringing Shan affairs of late into some prominence. With the railway from Thazi on the main Burma line to Taunggyi, the capital of the S. Shan States, within view of soon being an accomplished fact, and with the extension of the cart-road to the Salween, the opening up of the country will proceed with very rapid strides. The enormous energy represented by waterfalls will in the future without doubt form an important factor in bringing this about. The following notes on the principal waterfalls might therefore be of some interest. I should mention that all these falls are west of the Salween in tributaries of that river, with the exception of the Langa Rapids, which are in the Salween itself:—

1. *Staircase Falls* on the Nam Pang river, Kenghkam State, a few miles south of the town of Kenghkam. The staircase is some 1,200 yards long and 300 to 400 yards wide, with an approximate fall of 150 feet.



EARLY MORNING ON THE LANGA RAPIDS, S. SHAN STATES.

2. *Ta-hsai Falls.*—These falls are situated in the Kenghkam State at the junction of the Nam Pang and Salween, and have a drop of some 50 feet.

3. *The Teng Falls.*—In the Kengtawng dependency of the Mongnai State. Unfortunately these falls are not easily got at and less easily photographed. My first view of them was from a hill 13 miles away as the crow flies, and even at this distance the boom was distinctly audible. The Teng river divides into three branches and falls over perpendicular cliffs 200 feet and more in height.

The clouds of spray are loaded with lime in solution, which is deposited on the foliage several hundred yards around. On going close up under the fall between 8 and 9 A. M., one sees the remarkable phenomenon of a complete circular rainbow with a diameter of 12 to 15 feet, on the arc of which the spectator appears to stand. These and the Staircase Falls (No 1) are, I consider, the grandest sights in the Southern Shan States.

4. *Tam-upak Falls*.—In Hsatung State at the junction of the Nam Tam-upak and Nam Pawn. A fine fall of about 60 feet, but practically dry from March to May, as the bulk of the water in the stream higher up is drained off for irrigation purposes.

5. *The Langa Rapids.*—These rapids, of which a photograph is shown here, are situated in the Salween river, Mong Pan State. A good deal has appeared of late in the Burma papers regarding the navigability of the Salween. These rapids are by far the most difficult (if not insurmountable) obstacle to the navigation of the stretch of the Salween lying in the Southern Shan States.

Rubbers and Fibres.

THE following is the full text of Mr. Cameron's paper on "Rubbers and Fibres," read at the United Planters' Association Conference Bangalore.

MR. CHAIRMAN AND GENTLEMEN,—Three years ago I had the honour of reading you a paper on industrial exotics. Since that time considerable progress has been made in the acclimatisation of such plants, and knowing more about them, I make no apology for bringing forward the subject again to-day. The prevailing prices of coffee and tea are less hopeful than they were three years ago, and unless some unexpected reaction takes place in the supply from other countries, the outlook, especially in the former product, is not cheerful. But fortunately for the Indian planter, there is an increasing demand in the markets of Europe and America for other products which he may be able to supply; and it is concerning some of these that I venture, with your permission, to say a few words. In official correspondence with planters I am frequently asked for advice in the selection of cultures suitable to this part of India. This paper may, therefore, be of some general service as a *précis* of my views on the subject.

The vegetable products for which there is a growing demand are India-rubber, textile fibres, tans, lubricating oils and fancy woods. There are also numerous other products which it is impossible to refer to in one paper.

RUBBER-YIELDING PLANTS.

So pressing is the demand for good rubber at the present time that, while experts are exploring the world for further supplies, the chemists are actually trying to manufacture an artificial caoutchouc. If they should succeed in the latter attempt, rubber planting would, I suppose, become an unprofitable enterprise. But it is unlikely that they will succeed to copy nature exactly. I should here mention that an artificial product claiming to possess all the best properties of gutta-percha is now manufactured in Germany, and is used for insulating wires and cables. Then let us see, gentlemen, how we stand in regard to a possible rubber industry in Southern India. Of several rubber-producing plants on trial, the American trees stand out prominently in the estimation of the public. These are *Hevea braziliensis*, producing Para rubber, *Castilloa elastica*, the source of Central American or Panama rubber, and *Manihot Glaziovii*, which yields Ceara rubber; here entered in the order of merit as regards the quality and value of their respective rubbers. But the prominence of these trees is due to their extensive use and productiveness in America, where they form part of the arborescent flora of the country, and we have still to learn, to a large extent, how far they may prove remunerative to the State and planter when cultivated as exotics in this country.

This brings me to my own experiences of the three trees, and as far as their utility to Mysore is concerned, I am going to reverse the order of things by putting Ceara first and Para last. Within the past decade the Ceara tree has thriven amazingly, and has certainly come to stay in the country. It will flourish from the seaside to an elevation of at least 4,000 feet. Matured trees shed their seeds so abundantly that thousands of seedlings can be picked up wherever a few trees abound. Nor is it an unproductive tree, as it has so long been considered in this country. Recent tapping experiments in the Lal Bagh have conclusively proved that trees ranging in age from 8 to 14 years are highly chargeu with latex, and that the latter flows freely when tapped at the correct season and in the proper place. During the dry season, when the tree is leafless, the large root limbs should be tapped; and after the rains the operation should be transferred to the trunk, which yields its milk sap freely throughout the cold season. These experiments have also proved that, as regards the productiveness of latex, no two trees are exactly alike. Between the two extremes of a copious discharge and hardly any discharge at all, we seem to possess every degree of productiveness. This peculiarity does not appear to be due to

situation, exposure, or even the quality of the soil, in whole, as two trees growing together under the same conditions of soil, etc., were found to be wholly different in the amount of latex they contained. It seems to be rather a constitutional feature that some trees contain more laticiferous vessels than others. In view to ascertaining what quantity of rubber a mature tree will yield without being injured, a specimen has been tapped twice a week for the past three months, and the coagulated latex (it is not all pure rubber, as I shall explain later) now amounts to a trifle over 3lbs. The experiment is going on, as the tree shows no sign of exhaustion, either constitutionally or in the flow of latex. Early dawn is much the best time of the day for tapping, and the operation should cease about 8 A. M. The quantity collected from each of these tappings has varied from half an ounce to two and a quarter ounces.

What we have to do now is to raise nurseries of seedlings from the good trees and try to eliminate the bad ones. Being so hardy during long periods of drought, the Ceara tree would adapt itself readily to many of the scrub tracts at elevations ranging from 1,000 to 3,000 feet, with an annual rainfall of 25 to 40 inches. We know, of course, that it grows vigorously at higher elevations where the rainfall is heavy. But there seems to be a doubt (although nothing is proved) if the outturn of rubber would be as plentiful and good under the latter conditions of growth. Personally I am in favour of the maidan as the best location for a Ceara rubber industry on an extensive scale. This you will naturally think cannot be of much advantage to the planter, who is confined to the hills. But in a large concern of this kind the planter, with his matured experience and larger capital, is bound to have a share sooner or later. It is now proved beyond a doubt that the Ceara tree is wholly adapted to the climate of Southern India. It is also being proved that as it approaches maturity some varieties of the tree are highly charged with latex, and I may here state that the dry climate of the plains is all in favour of a pure rubber being easily prepared from the latter. American imports of the rubber into the United Kingdom are valued at a somewhat lower rate than similar products of Para and Castilloa. But with the improved methods of purifying the actual rubber by the extraction of hurtful ingredients, such as phosphates, resin, and albuminous matter, the best tree of the future will be the one producing the largest quantity of pure rubber or caoutchouc. The latter is suspended in the latex fluid in the form of minute globules, and needs to be separated in much the same way that cream* is separated from milk. An ideal preparation of pure rubber would be to drain the latex from the tree by means of a syphon into a kind of churn where the caoutchouc is separated by centrifugal force. It follows from this that any rubber at once depreciates in value when it is allowed to coagulate with all its impurities as it is taken from the tree. This ball of rubber, for

instance, which was taken from a tree a few days ago, is full of hurtful ingredients rendering the whole mass subject to the growth of fungoid disease and putrefaction, results which are greatly aggravated in a damp climate. The old American remedy to prevent disease was sun drying and smoking. But that is only partially effective and does not purify the rubber.

We now come to a brief review of *Castilloa elastica*, which has also attained the reproductive stage in the Lal Bagh. In its culturable requirements this important tree seems to be intermediate between the Para and Ceara species, requiring neither the tropical humidity of the former nor the open and comparatively dry conditions of the latter. It is, in fact, a tree for the coffee zone, as, no doubt, some of you have already discovered.

Mr. C. O. Weber, an expert, who has recently visited Castilloa, a plantation on the Isthmus of Colombia, writes thus:—

"All the reliable evidence seems to show that the trees grow badly in dense forests, and produce a poor yield of rubber when grown on open ground. They appear to prosper best when growing up together with other trees, so that the trunk is always shaded, whilst the top of the tree, at least for a certain time during the day, receives the direct rays of the sun." These are the conditions which I have also found most favourable to the growth of Castilloa at Bangalore. Our trees, which are about nine years old, have only been tapped very slightly in one or two places to see if the latex would run freely. It appears to be a characteristic of at least two varieties of the species that the latex does not run freely, but collects in beads and tears under the punctures. Local trees are apparently of this class. Mr. Weber further writes that in Mexico and Ecuador the latex fluid runs freely. Three distinct varieties are described by this authority, *e.g.*, *C. elastica alba*, the richest variety, producing a thick creamy milk. *C. e. nigra*, yielding a thin fluid, and easily bled to death. *C. e. rubra*, affording good rubber but deficient in quantity. These names (which indicate the colours white, black and red) have reference to the colours of the bark in the different varieties, there being no botanical difference. The first named is apparently the best tree to get hold of. The seed of Castilloa ripens here in May. But as yet we have only a limited quantity—3,000 seeds were sent out to planters this season. It loses its vitality in a few weeks if not sown, and I have not observed any self-sown seedlings under the trees, as happens in the case of Ceara. But there will be no difficulty about propagation as the species increase in age and number. I only hope we possess the most productive variety. What has been said previously about centrifugalisation applies with even greater force in the preparation of this valuable rubber, which readily blends itself to such treatment. There is a large percentage of

albumen in the latex, which if left for even a short period would cause fermentation in the solid product.

Although I do not say positively that Castilloa would fail on the maidan, I certainly think it will have a better chance in comparatively open spaces throughout the coffee zone. Indeed it may become a good shade tree for coffee for all we know at present.

Now we come to the last of the three American trees, *e.g.*, *Hevea braziliensis* or Para Rubber. When pure, the latter is worth Rs. 4 a lb., and is admitted to hold the market at present. But under improved methods of preparation it will soon be closely run in quality, and perhaps greatly exceeded in quantity, by the rubber which I have just reviewed. Anyhow, it is not likely to be of much practical use in the drier parts of India: therefore, we are justified in turning our attention to more hopeful subjects. The Para rubber tree is essentially tropical in its requirements, and needs a humid atmosphere such as is found in the Amazon Valley—its native habitat. Ceylon has started cultivation in a small way. But the only Eastern country which is likely to compete on fairly equal terms with Amercia is the Malay Peninsula and Archipelago. Along the West Coast of India, and in moist situations under the Ghauts there may be spots where the climatic conditions are tolerably favourable. But careful experiment should be conducted before a large investment is made. At Bangalore the tree languishes and dies during the long dry season. Irrigation gives only temporary relief, as there is too little moisture in the first four months of the year.

The Assam rubber tree (true India-rubber) *Ficus elastica*, I have all along said will grow well in the coffee districts, and the reason why it is not found there in quantity is possibly due to the difficulty of rapid propagation. But in any South Indian rubber plantation this useful tree should certainly find a place. It is said to be doing well in the Straits Settlements.

Much nonsense has been written lately concerning a new rubber plant—*Landolphia Thalloni*—found on the French Congo. I have little doubt, too, but some of the writing was done to influence the rubber trade, for good or otherwise. The latex of this little shrub, which is only half a foot high, is chiefly stored in the root. But this is not an exceptional discovery, as I have shown in this paper that the roots of the Ceara rubber tree are full of milk sap. So are the roots of several species. Scientific experts who are in the best position to judge are not of opinion that this latest discovery will influence the rubber market greatly. They rather expect that many similar discoveries may be jumped upon us during the next few years. The African genus *Landolphia* promises to be a large one, and doubtless all the species contain latex. We have one or two species on trial which grow well. But as climbing plants they are not, in my

opinion, very suitable for rubber farming in this country. Should we be driven to utilise climbers in preference to trees for our supply of rubber, which is improbable, the long established *Cryptostegia grandiflora*, a plant of Madagascar, offers a richer source of rubber, I believe, and it can be grown without trouble. It is known around Bangalore by the local name *Mate wuli umboo* In concluding these details of my own experience with some rubber yielding plants you will gather, gentlemen, that I favour the selection of Ceara for the plateau of Mysore and Castilloa for the moister region of the hills. Para may succeed in parts of tropical West India; but of that I am uncertain.

FIBRES AND SERICULTURE.

The fibre industry is passing into the practical stage, and seems to hinge, at present, on capital outlay and a good market. Cultivation, as I told you on a former occasion, is assured in this country, where there are fibre yielding plants suitable to almost every condition of soil and climate. The plants most suitable to the tea and coffee tracts are those producing Rhea hemp, Mauritius hemp, and perhaps Manila hemp; while at the highest elevations on the Western Ghauts, in somewhat sheltered positions, of course, an unlimited supply of New Zealand flax (*Phormium tenax*) and Bon Rhea (*Villebarnea integrifolia*) could be produced.

Sericulture is also well worthy of trial in the drier districts. In connection with the latter industry the new Japanese reels recently imported by Mr. Tata promise to increase the value of local silk by at least 50 per cent. A consignment of silk thus reeled on Mr. Tata's farm, has been valued by the Home brokers at Rs. 13 per lb., and is highly praised for its excellent quality. Silk prepared by the native method is only worth Rs. 5 to Rs. 6 per lb. What we really require for our Indian industries is the best class of machinery that can be procured. Even the few products which I have named require three distinct machines or apparatus. These are, firstly, a powerful engine with decorticator, like Todd's, (costing £600), to manipulate strong leathery leaves such as afford the so-called aloe fibres, bowstring hemp and New Zealand flax. Also Death and Ellwood's scraping wheels worked by Marshall's portable engines. The latter appear to be exclusively used in Yucatan, where a single wheel can clean leaves at the rate of 20 per minute. For further information on this point, I would refer you to an interesting article which appears in the last issue of *Planting Opinion*.

Secondly, a machine after the style of Faure's, priced, I believe, at £100, to deal with the more delicate fibre of Ramie, Rhea, and possibly Manila hemp. Then we find that with proper reeling the value of silk is greatly enhanced. It is not, however, necessary that every grower of fibre should possess a machine.

The one used by the South Indian Fibre Company is carried all over the country-side, just like a threshing machine at Home. It would be the same in dealing with silk, which is not a bulky article. One central depôt for reeling should suffice for a large area. Although essentially a poor man's industry, I see no reason, especially in times of planting depression like the present, why the planter should not have a mulberry patch and try his hand at sericulture.

In Assam, the Bengal Rhea Syndicate possesses a large area of cultivation, and it is highly probable that Ramie and Rhea may do for the north of India what the aloes and hemps are expected to do for the south.

The common railway aloe, *Agave americana*, has risen to the expectations of the South Indian Fibre Company, whose best consignments have realised as much as £32 per ton of clean fibre. This only shows what a splendid opening there is in this country when Sisal and other first class fibres shall be established in quantity, and supplies assured to the brokers at Home. Another healthy sign is the increasing local demand for plants of Sisal and the Mauritius hemp. At the gardens we are booked for all that can be raised during the next two years—approximately a couple of lakhs. Fortunately our Sisal plants have commenced to pole and propagation from that source already amounts to about 18,000 plants.

There are in Mysore alone, as you well know, immense tracts of poor, but still comparatively good, land under scrub. Many of these tracts, situated near the railway, I should like to see taken up for the cultivation of fibre and Ceara rubber, of the success of which, if properly taken in hand, there can be no doubt whatever. At present the two redeeming products on these lands are grass for cattle and the tanner's shrub, *Cassia auriculata*, yielding *tangedu* bark, the staple tan of the province. High prices are offered for the best tans, evidently because natural supplies are unequal to the requirements of the time. The pinch is being felt, for instance, at Cawnpore, where there are extensive leather and boot factories. The babul tree, which furnshes the bark in that locality, is becoming exhausted, and to carry bark in bulk from distant parts of the country is too expensive. For this reason, and for its richness in tannic acid, the comparatively light pods of the Divi Divi tree command a high price and are eagerly sought for. Plantations of this useful tree should certainly be raised at elevations ranging from 1,000 to 3,500 feet, with a rainfall of 30 to 70 inches. The Divi Divi is a very hardy and long-lived tree, which becomes more productive of pods (fruit, up to at least 60 years of age. It needs an open situation with good drainage. I am now in a position to supply a large quantity of seed, should it be bespoken some months before the ripening season at the close of the hot season.—*Madras Mail.*

Working of State Forests in Russia.

THE *Journal de St. Petersbourg* of the 15th May summarises a report published by the Russian Ministry of Agriculture and Domains on the working of the State forests during 1901.

The gross revenue derived from this source is given as 57,486,900 roubles or six millions sterling, of which 54,546,029 roubles resulted from the sale of forest products, an increase of 384,258 roubles compared with the previous year.

The forest lands under the general forestry administration on 1st January 1901, covered a total area of 237,927,789 dessiatines (dessiatine = 2·7 acres), consisting of 12,520 different forests, an area which was augmented during the year by 921,960 dessiatines, principally in Asiatic Russia.

On the other hand, forests under the desmesnial forestry administration showed a total diminution of 256,614 dessiatines, the result of a revision of the forest boundaries.

The net result shows that on the 1st January 1902 the forest lands placed under the jurisdiction of the general forestry administration amounted in area to 238,593,155 dessiatines consisting of 12,562 forests.

Paper Mills in British India.

THE following particulars concerning paper mills in India have been received at the Board of Trade through the India Office :—

There are eight paper mills in operation, three in the Bombay Presidency, four in Bengal and one at Lucknow. Out of the eight, two are private concerns in the Bombay Presidency. The capital invested, so far as information is obtainable, amounts to Rs. 73,20,000. Most of the white and blue foolscap and much of the blotting paper, notepaper and envelopes used in the Government offices is now obtained from the Indian mills. The total quantity of paper made in 1902 was nearly 47 million lbs., and its reported value Rs. 64,38,319. The mills employ 4,865 persons. The capital employed has been trebled in 20 years, since 1883, and the production and number of persons employed have increased about six-fold. But in recent years there has been a depression in the paper making industry in Bengal, owing to the importation in large quantities of cheap paper made from wood pulp, which is of more attractive appearance, if less durable, than paper made from grass, gunnies, and rags in the Bengal mills.

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The following table shows the progress of paper mills in India during the last five years :—

	Number of mills at work.	Capital employed (as far as known).	Daily average number of persons employed.	Production.	
				Quantity.	Value.
		Rs.		lbs.	Rs.
1898	8	62,72,000	4,187	42,181,500	61,06,459
1899	8	67,72,000	4,436	44,428,440	62,40,905
1900	8	70,22,000	4,871	45,940,591	62,51,748
1901	9	73,20,000	4,978	46,713,125	65,83,724
1902	8	72,20,000	4,865	46,654,853	64,38,319

VII.—TIMBER AND PRODUCE TRADE.

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On Certain Important Forest Questions.

By J. S. Gamble, F.R.S., C.I.E.

The August number of the *Forester* has just come, and I hasten, as an old editor of the Magazine, to offer you and your colleagues my congratulations on the interesting papers I have found in it.

Two of them, in particular, seem to require some remarks, and I hope you will allow me to give my opinion on certain of the questions raised in them. To some of the others I may refer separately, but the two papers referred to—the two first in the number—refer to questions of the highest importance to the welfare of the Department, and I think it best to send you what I have to say as quickly as possible.

The second paper contains Colonel Pearson's interesting reminiscences, which, I feel sure, all your readers will hope he will continue. Among old pioneers of the Department were several whose names and work might get lost sight of if nothing is done to recall them to memory. The "Highlands of Central India" was, and is still, a classic work on Indian jungle life and Indian sport: it also contains much information about the beginnings of forest work in the Central Provinces, but its author was too modest to say much about himself. Colonel Pearson has therefore done well to tell us something about Captain Forsyth, and I hope that he may be induced to tell us more. I have been greatly pleased to find that he has recalled to notice Major Douglas, for he was the first Divisional Officer I served under, in the Tharrawaddy Division in Burma, and I had already known him because when I was at Nancy he came there when on furlough and spent some time with us both in the lecture-room and on tour in the forest. He was one of the best of chiefs and most lovable of men, and the picture of him which I still possess I value highly. He was "a fish out of water" in Burma: accustomed

to Hindustani peoples and Central Indian jungle tribes, he did not take very kindly to Burma ways. He was far more interested in such work as he had been doing in the Central Provinces and Berar--the selection and demarcation of reserves, their opening out by roads and paths, their protection from fire, and the supply of material to villagers—than in the timber works of Burma—the operations of girdling and extraction and the collection of a large revenue. His move to Burma affected his health and energy, and when, too late, he was transferred to the Punjab, it was only to die without having the chance of becoming a Conservator. I hope Colonel Pearson will tell us more about him and of other similar pioneers of Indian Forest Administration. And here, Mr. Editor, may I suggest to you the compilation, say, for those officers who served in the Department during the 19th century, of a list, with brief biographical notes on those who are no more.

I am glad that he noticed the great services which the late Sir Richard Temple rendered to the establishment of forest conservancy, and as one who on several occasions accompanied Sir Richard on his tours in the Darjeeling hills, I can say that Lower Bengal forestry at any rate had no better friend, unless perhaps it was Sir Richard's predecessor Sir George Campbell, or his successor Sir Ashley Eden, for all three took the greatest interest in the welfare of the Department, and all three I am sure held strongly the opinion that its officers should be scientific men.

The point in Colonel Pearson's most interesting paper which has most particularly drawn my attention is where he says: "The use of the term 'Conservator' was also deliberately adopted by Government, as indicating more strictly the first duty of the Forest Department. Then, as now, there was a disposition in some quarters to insist on its being a revenue-producing department, an idea which, if carried out, would necessarily end in forest destruction." This is a most important remark and one which cannot too strongly be kept in mind, for, if I mistake not, the tendency of the policy followed by some of Colonel Pearson's successors has been to make the Department in the first place a "revenue" one and to some extent to relegate conservancy and improvement to the background, especially in some Provinces and most notably in Burma. In my opinion, and I believe I am not alone in the opinion, making the collection of a large surplus revenue the chief aim of a Forest Department is a dangerous policy in several ways, and especially as it may so very easily lead to over-cutting, to the neglect of works of improvement, to a falling off in the quality of the staff and in the interest taken in their work by both officers and subordinates, and to the gradual replacement of forest conservancy by forest "destruction" or at any rate "deterioration." In a recent paper read before the Royal Colonial Institute

I said: "I believe it to be a wrong policy to gauge the work of such a department and of its individual officers, as is only too often done, by the amount of their financial surplus. It is for the Government to decide what, and how much, produce is to be given free, but the consequent reduction of revenue ought not to *be made the reason for the reduction of staff, a curtailment of* work and a consequent loss of efficiency. Forest conservancy has a higher aim than that of merely giving so much revenue, and it is a mistake to encourage officers to risk over-cutting their forests in order to please the financial authorities. We have sometimes been made to understand that if we require a better staff and more expenditure on important works of administration and improvement, we must first show that they will pay, and for my part I believe this principle to be wrong."

Having drawn attention to Colonel Pearson's opinions and explained my full concurrence in them, I should like to turn to the first paper in your August number, in which another former Inspector-General of Forests, Sir D. Brandis, adds to an appreciation of the services of the late Inspecter-General Mr. Hill, whose recent sad death I and all his friends have been so sorry for, a few remarks all of which I am not quite sure Mr. Hill himself would have fully approved. Sir D. Brandis says: "The forests of Lower Burma had, since 1856, been worked on a well-considered plan, and had ever since that time yielded a steadily increasing annual crop of teak timber and of revenue. Now, since the annexation of Upper Burma, the net annual revenue produced by the Burma forests equals the net forest revenue of all other Provinces taken together. It stands to reason that service in Burma must be regarded as a necessary preparation for employment in the highest appointments." *Here* we have an indication of an opinion which seems to differ considerably from that of Colonel Pearson. I believe I am right in thinking that, at the present time, forest management in Burma is too much subordinated to the production of revenue. The selection, demarcation and settlement of permanent reserves, a work which elsewhere is completed or nearly so, is still very much behindhand in Burma. Fire protection, as we know from the correspondence that has gone on in the *Indian Forester* for several years, is in a backward condition, many officers expressing openly their disbelief in its utility. Of roads, not merely for export but for inspection and forest protection, there are practically none; *houses for the staff have hardly been started; and* the only works of importance that have been carried out, if I am not misinformed by the reports I have read, are the clearing of streams to improve them as waterways for timber floating, a very important work no doubt, but all the more useful if supplemented by good roads rendering access to the forests easy and simple. I see too, from your pages, that no good plans of campaign have

been organized to deal with the critical period which will come when the bamboos flower. Excellent work in taungya plantation has been done; but what works have been done in those reserves where taungyas are not cut and where the constant extraction of only teak *must* be impoverishing the capital of the forest and encouraging less valuable species? In a recent number of the French forest magazine, the *Revue des Eaux et Forêts*, was published an extract from a report by the French Consul at Rangoon dealing with the teak trade. He says: "The remarkable decrease in the export trade in teak wood, and especially to England, is attributed to the small amount arriving in Rangoon and also to a notable falling off in the quality of the wood, timber suited to European requirements arriving in less and less amount each year. The total imports of teak wood into Europe during 1901-02 fell nearly 40 per cent, while the consumption only decreased 15 per cent. England seems to be losing its monopoly." *How far the Consul's statements are accurate I* have no means of ascertaining, but it rather looks as if, in the desire for revenue, the quantity cut for some years back has been greater than it ought to have been, so that the reaction is now beginning to be felt. I cannot say that I regret it, but I think that if the Burma officers could have their energies diverted for a time from the necessities of making large surpluses and could devote them to the consolidation and improvement of the estate, it would be a good thing in the end and give the new stock a little time to grow. I expect that in most Provinces the story is the same, in a greater or less degree, though I think that, of late years, there has been an improvement elsewhere than in Burma, and most of all in those presidencies where forest matters are not so directly governed by the Inspector-General's advice as they are in the north and where service in Burma is not "a necessary preparation for higher and more responsible positions." *

That arrangement of sending officers to Burma to qualify for promotion is, to my mind, a mistake. The opinion of a really good officer will always be of value, whether he has actually served in the locality or not, and just as a good officer was wasted when my old chief Major Douglas was transferred to Burma, so work in two Provinces may be retarded by sending a man from one which he knows thoroughly to another of which he knows

* Whilst printing our correspondent's article *in extenso* we would wish to disassociate ourselves from some of the opinions expressed therein, for which the writer is solely responsible. We trust that those Officers who have been, we feel sure through inadvertence, to some extent unfairly criticised, and those Provinces in which the progress of Forestry, owing to an evidently imperfect knowledge of the true state of affairs at the present time, has been adversely commented upon will find defenders. We shall thus be able to satisfy our distinguished correspondent, whose evidently keen and laudable interest in the welfare of the Service he so worthily adorned we all applaud, that his fears on the score of the quality and quantity of our progress since he left us are groundless.—HON. ED.

very little. Then, too, there is the certainty that if not eventually given the promotion he has been sent to qualify for, he will ever after have a grievance. I think that I am just in saying that it is not to Burma that an officer would go to see the best systems of demarcation and settlement, the best fire protection, the best working-plans, the best communications, the best system of housing the subordinate staff, the best planting work, and the best arrangements for the extraction of timber. To really qualify, an embryo Inspector-General should see something of all Provinces, and that is manifestly impossible.

I should now like to say something on the "Botany" question. Apparently our old Inspector-General has persuaded himself that "shikar"* is the real special subject that Forest Officers should study. I may be wrong, but I do not think that this was always his opinion. There are plenty of officers who would be glad, I expect, if the Government took the same view, though it is hardly likely to, and nowadays few Forest Officers can get any time for shikar, for there are too many reports to be written and every moment available for out-of-doors has to be devoted to inspection, which usually means the companionship of quite a large following and the consequent absence of any chance of game. Those officers who do much shikar generally take, I think, an occasional holiday for the purpose, and a good thing too; but shikar and inspection are, I maintain, incompatible, for either you see the game and fail to remark what is doing among the trees or you see the trees and the game gets away. Sir Dietrich says that "many English botanists" hold the opinion that a good botanist must necessarily be a good Forester. I should like to know on what grounds he makes that statement, for though I have myself a considerable acquaintance among English botanists, I know of none who have, or were likely to have, said any such thing.

What some botanist may have said is that, *cœteris paribus*, the officer that is at home in the forests knows the trees that he has to deal with or can easily find out about them, knows their value economically and sylviculturally and so on, is likely to be a better man than one who does not. Sir George King, as an instance, said in his address to Section K at the meeting of the British Association at Dover in 1899: "To most people who give even casual attention to the matter, it appears fitting that the possession of a knowledge and liking for Botany should form a strong characteristic of officers whose main duties are to be in the forests.

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* The writer would seem to have misread the article in question. Sir Dietrich says (on p. 312): "Both love of sport and devotion to Botany and Entomology are most useful *helps, but they are not Forestry.*" The italics are ours.—HON. ED.

I well remember the secret feeling of despair which I had when, in 1872, I was sent to work in a region of many trees very little known. There were no "Forest Floras," no "Flora of British India," no lists with native and scientific names, and except one or two kinds nobody knew which trees had good timbers which worthless ones, what kinds were useful for building, which for fuel, what for valuable minor products and so on.

I found some small acquaintance with Botany and some capacity of studying such books as there were a great help, and it always beats me to imagine how men who really love the study of sylviculture can get on without rather more personal knowledge of the trees concerned than is given by a mere knowledge of the name and often not even of that. If he is to be really useful a Forest Officer has not only to know his trees, to understand their value and their physiology and how to make the most of their products, but he has to be also more or less a zoologist, a geologist, etc. It will be a bad day for the Department when it gets to be supposed that an officer need know none of these things, when he loses the prestige of being a scientific man and appears openly as only an official timber merchant with a dash of the policeman. Then there will be no need for Forest Officers, Burma-trained or otherwise, as Inspector-General or even as Conservator; a few junior Civilians will do as well; forest schools to teach useless subjects will be unnecessary, and the fabric of which most of us, and I feel sure, more than any, Sir D. Brandis himself, are proud, will crumble away. No! I say it emphatically if the Indian Forest Department is to preserve its prestige, it must be a scientific department and its officers must be capable of advising on all subjects connected with trees and forests and their treatment.

To think that the old Forester who, as he himself tells us, had the chief work in starting the Department, can imagine that the solution of "the problems of sylviculture and of forest management in a practical manner" can be effected without a good acquaintance with the individual species which make up the forest is a strange thing, and for my part I hope that the authorities will not take his opinion too seriously. The fact is, I expect, that he and others have a wrong idea in their minds in talking about "Botanists" or "Entomologists" or what not. They imagine such people to be those who think of and do nothing else; they have in their mind's eye the man with the collecting tin, only interested in the search for rare plants, or the man with the butterfly net and collecting tubes, or him with a hammer and chisel and a bag of rocks; but those are not the kind of persons that we necessarily want or that we need think of. The botanist or other "ist" that I should think of would be the one who keeps up his Forest School teaching in after times, who if he met with a tree he does not know can successfully use a "Flora" and

with it find out what use it is and how it is to be treated, who understands well the main principles of plant physiology, who if he comes across an insect doing damage knows how to go to work to find out what it is, and so ascertain what is known of the means of preventing its damages* and so on. A few men who are specialists are doubtless useful in the staff of a Forest Service, but it is not specialists that are required, but that all officers should know sufficient to be able to use their powers of observation with advantage, and to the benefit of their work. An officer who cares only for new plants, a new insect, a rare mineral or a pretty photograph is not likely to be in the first rank as a sylviculturist, any more than the one who is only interested in shikar or in polo or in lawn tennis or in billiards ; but in a general way they are all useful things, and so far as the present mania for reports and correspondence allows, every officer should, I think, have a private study in addition to his work, if only as something to fall back upon when at last his pension time arrives and he takes his place among the unemployed at Home. The private interests make life in India much more endurable, and when these interests are of a kind to be useful in the officer's own work, it is all the better. I can, myself, call to mind the names of many of my contemporaries who had useful hobbies, and I can also call to mind many who were good all round with a sufficient knowledge of most of the necessary subjects and capability of using that knowledge. Careless writing, like that of Sir D. Brandis, is only harmful and dangerous, and, as I have before remarked, I only hope that the authorities at the India Office and at the Supreme Government in India will not attach too much importance to it, and indeed, I may add that I hope that it will not make the young men now in training at Cooper's Hill or Dehra Dun think that they can dispense with the study of scientific subjects which they are expected to pass in, and on a knowledge of which their careers in India will so largely depend. Shikar is an excellent amusement and is often a necessity, as the poorest shot knows well, for there may easily be cases where his dinner depends on his success ; but it is not the only pursuit, or even the best pursuit, which will induce a man to " make the forest his home " and learn to understand it, to observe all that is going on, to devise improvements in administration, and when he leaves it finally to feel that it is in a better condition in every respect than when he assumed its charge. Every officer in the

* Mr. Gamble neglects to inform us how the Forest Officer is to attain this enviable position in the total absence of Indian works on this subject. He himself tells us that he felt a feeling akin to despair in 1872 when he went to work in a region full of unknown trees. To the work of specialists, amongst whom he holds a place in the foremost rank, the Department owes the excellent " Floras " now in existence, and to the work of entomological specialists, and these will have to be found in the ranks of the Service itself, will the Department have to look if it is to be placed in a similar position with regard to a working knowledge of its insect foes.—HON. ED.

Service is called upon at some time or another to prepare working-plans. *He has to begin with a description of the locality* and bring in his knowledge of meteorology, geology and the composition and value of different soils. He has to go on to describe the forest growth and the idiosyncracies of the different species composing the forest as regards light, heat, climate and soil. He has to study the field agriculture of the surrounding *district and the mutual relations* between it and the forest. He has to describe and, if possible, map the boundaries, outer and inner, and apply to the subject his knowledge of surveying and geography. He has to study the legal position of the area and has often difficult questions to deal with in special systems of revenue settlement peculiar to the place. He has to describe carefully and carefully classify the forest crop on the various parts *of his area, study its component kinds and their sylvicultural* requirements, notice the various kinds of produce that it yields, capable of utilization for timber, fuel, minor wood industries, extracts for tanning, dyeing, medicine and other purposes; report on the injuries to which the crop is liable: fire, frost, climbers and parasites, grazing, insects, fungi and what not, with the best way *to meet them.* Then he has to describe the roads and rivers and other works of engineering met with or required, the markets for produce, and their positions and wants and the methods of extraction of material.

And when he has gone into all these questions, requiring not perhaps high special scientific knowledge, but a sound training *in some* substantial part, at any rate, of many subjects of both pure and applied science, he has to prepare his plan of working which is to last for many years and provide for the yearly utilization on the interest on the capital stock and the progressive improvement of the capital. Can it be said that all this (my description of subjects is taken from the Government authorized text-book on the "Preparation of Forest Working Plans for *India") can be done by a practical man without regular training* and without a proper knowledge of Botany and allied sciences? I feel sure that most impartial people will say no! As a final remark, I may suggest to such of your readers as are still sceptical, the study of the article "Forestry in America," by H. J., the commencement of which appears in your August number at page 323. If that does not convince him that Forestry, itself, I maintain, a scientific subject, cannot do without the aid of Botany and other allied sciences, I do not know what will. Indian Forestry, as Colonel Pearson says, must be something more than the mere collection of revenue if it is to maintain the position it has in India and the prestige it enjoys outside Indian limits.

The Training of Forest Officers.

OUR readers will have perused with interest an article on the training of Forest Officers from the pen of Colonel Pearson—an article which the Service will be proud of, since it proves the keen interest which its senior retired officers maintain in its efficiency, prosperity and well-being. We are happy to think that as long as those who have so brilliantly distinguished themselves whilst serving on the active rolls continue to evince, this keenness in our welfare we are not likely to deteriorate. There can be little doubt that the expression of their opinions on this important question of professional education, both by those on the retired and those on the active lists, would be of considerable value at this juncture, seeing that the Service is practically face to face with another threatened change in the training of its recruits. Colonel Pearson invites discussion, and his article affords plenty of food for serious thought and grounds for argument both for and against his propositions.

We have already advocated in the pages of this Magazine what we consider the ideal plan, the plan which we, as a Service and as the only trained Foresters in the Empire, know to be the true solution of the difficulty which may shortly have to be faced, our suggestion being the formation of an Imperial Forestry College and the training in England of English Foresters for service both at Home and throughout our dependencies. This is an urgent need of the Empire. We have suggested that, in the event of the Royal Indian Engineering College being closed as an Indian P. W. D. training ground, Cooper's Hill, owing to its many advantages for the purpose in view, should become the head-quarters of the Forestry College.

But whilst thus advocating the question of the maintenance of and the imperialization of the College, whether for the teaching of Forestry or—for the suggestion appears to be an equally sound one—for the training of both Forest and Engineering students for service in the Empire as a whole, as we have recently seen proposed in the columns of the *Pioneer*, it will be well that we should not lose sight of the other ways of dealing with the question—that we should not, in fact, place all our money upon the one horse, only to find that it gets 'left' and remains behind in company with the starting machine and its operator. We would wish therefore to consider here Colonel Pearson's proposition or suggestion of a return to the old system of training, a return to the Forest colleges of the Continent. This question, as in the case of the others, should, we think, be looked at in all its bearings and be thrashed out on its merits. We are aware that many of our best scientists have in the days of their youth studied in the lecture halls and worked in the laboratories of the great German specialists. We know that to-day many English students go to these German science schools for that thorough grounding in their subject which

the supineness of our own nation in such matters precludes their obtaining at Home. And we ask, "Are they not justified in so going?" Whilst the hallmark "Made in Germany" is often synonymous in the commercial world with the cheap and nasty, that same hallmark in the scientific world has long been acknowledged as being very much the reverse. And though made in Germany the Englishman does not remain there. Owing to some constitutional deficiencies he apparently usually requires more to eat than his German confrère, and therefore has to seek out spots in his own Empire where his pay will be more commensurate with his grosser appetite. It follows that the man himself and the Empire both benefit. It may be granted that this is not as it should be; but until we, as a nation, place the telescope at our seeing eye the true position of affairs will not be perceived. We are here concerned with facing realities, not the might be's. We think therefore that this question of a return to the Continent should not be approached in a spirit of carping criticism, but rather that it should be discussed in all its bearings in as judicial a frame of mind as any of the other proposals *sur le tapis*, since our first thought must be the well-being of the Service, and that well-being is entirely dependent and wrapped up in the kind of men recruited and the thoroughness of their Home training. That we all admit.

We are, however, of opinion that a return to a Continental college, should it become necessary, would require a modification of the old arrangements. The students during their stay at the college should, whilst getting the best of the Continental training, at the same time in some way be shown how the principles they are being taught bear upon Indian Forestry, be taught something about Indian trees, how to apply to Indian conditions what they have learnt in the European schools, etc., and that information would be required to be given at first hand week by week in the lecture-room as well as in the forest. As in the old days, there should be a Chief, of the rank of a retired Inspector-General, who would still be required to exercise a general supervision over the students' work, to perhaps accompany them on some of their more important tours, and to be the responsible officer to represent the India Office with the Continental college authorities; but we venture to think that something more than this Chief in necessary. With a couple of dozen students, which the numbers of the three years would total up to, it would be quite impossible for the Chief to cope with the necessary lectures, nor indeed would it be compatible with his position as the representative of the India Office that he should undertake such duties.

For the special Indian lectures at least two men would be required, and we would suggest that such men could be best found in, and taken from, the ranks of active members in the Service itself. Keen men and good men would be required to

fill such posts, as on them would almost entirely depend the efficiency of the recruits coming out; but there would be no difficulty in obtaining them. In fact we surmise that the difficulty would rather be the other way, when it became only too apparent that the numbers to select from were only too numerous. These two officers would remain in residence at the college and should be made entirely responsible for the discipline of the students and for the manner in which they worked, etc. The details of fixing the hours of the Indian lectures would be a matter of simple arrangement with the college authorities. Under some such plan the senior officer in residence would hold much the same position as regards authority and discipline as is held by Dr. Schlich at Cooper's Hill, the Chief occupying one analogous to that of the President of Cooper's Hill. The introduction of this scheme would have several advantages. The men deputed would themselves greatly benefit by such a deputation and through them the Department. The fact of there being such posts available would form an additional incentive to the hard and keen workers, men who now look in vain for any stray plums on the Forest Tree,—that Tree of the many branches immortalised by a former Inspector-General. For although the Department knows how to grow trees, it certainly does not seem to be able to make this particular one bear much fruit, or is it that the foliage is so thick and dense in the lower portions that the twigs wither, die and drop off in their efforts to push up higher and see whether it does produce an odd plum or two? But the great advantage would, we think, lie in the fact that the Forest students would have as their Indian lecturers men straight from Departmental work and absolutely *au courant* with the changes that were taking place. The dictum *Tempora mutantur nos et mutamur in illis* is very true, even in the unchanging East, and perhaps nowhere more so than in the Forest Service in India. One has only to compare the progress made in the last decade with that of a decade before to become aware of this almost self-evident fact. As this progress is likely to be equally rapid in the future, we consider that the two lecturers on the Indian portion of the curriculum should be kept equally progressive.

We feel sure that in thus writing we shall not be considered to be in any way reflecting upon the present training of the Departmental recruits. We have already considered that subject and we would wish to see the present college and method of teaching put on an even wider basis. We are here dealing with the subject from one of the other points of view. In the event of the students going to a Continential college, the teaching posts available could only be taken by more junior men, and these could only be successfully looked for in the active service lists. We feel sure that our meaning will be clearly understood and

that with us all *Salus populi suprema lex,* the Service taking the place of *populi.*

With regard to the selection of the officers to be deputed, we would suggest that the senior should have from 18–20 years' service, in fact be a budding Conservator, whilst the second should be sufficiently his junior to avoid there being any question as to the authority of the senior, *i.e.,* he might be chosen from 15-year service men. The officers so selected would be seconded, and their deputation might be for a period of three years corresponding to the length of time passed at the college by the students. This would reduce to a minimum the chances of a man getting stale and would bring in a succession of men fresh from actual work in the field.

We throw this out as a suggestion. Others will perhaps have better ones to make, and we trust they will give the Service the benefit of their ideas upon the subject. There is one point upon which, we think, too much stress cannot be laid and upon which in all probability most agree. The Forester to be really efficiently trained requires special courses of lectures in the various branches he has to study, and these he cannot obtain except at a Forest College *proprement dit.*

Notes on Indian Trees, II—Notes on Hopea odorata.

BY D. H. ALLEN, *Forest Ranger.*

Hopea odorata, Roxb. Vern. *Thingan*, Burma.

A LARGE evergreen tree sometimes attaining a girth of over 12 feet.

Bark dark brown with deep longitudinal furrows, about half inch thick; the younger shoots are of a greyish colour. The leaves in some specimens are oblong, inclined to be lanceolate, in others ovate; young leaves puberous, becoming glabrous as they get old.

The flowers are small, white and very fragrant, growing on very short stems. The fruit, a nut, is attached to a calyx with two long and three short lobes. This description agrees with that given in Kurz "Forest Flora."

The flowers appear in March and continue till April. The fruit appears in May and June.

It grows mixed with other species in the tropical forests of Lower Burma and is also found in the Pyinmana district. In Mergui and Tavoy it is plentiful. It grows up to an elevation of about 1,000 ft.

The colour of the timber varies from yellow to brown. The timber is hard, heavy, close and even-grained. It is said by the timber traders of Mergui that trees with narrow leaves have harder and better timber than the trees with rather broader leaves. The specimens of the former kind are said to grow chiefly in valleys and small hills, the latter on low-lying land and along the edges of the larger streams. The wood is very durable. It is used in Mergui chiefly for boat building; boats built of thingan are said to last longer than boats built from any other timber found in Mergui. Although attacked by *Teredo navalis* it is less susceptible to their attacks than the other timbers known here, except perhaps *Fagræa fragrans*.

While on the subject of boat building it may be of interest to mention the way the people here preserve their boats from the attacks of *Teredo navalis*. Once every month or so the boats are taken out of the water and raised off the ground by placing two logs or anything else that may be suitable under the two ends of the boat. A lighted torch made of split bamboo is then held and moved about under the boat till all the water that the wood has absorbed evaporates; this burning operation lasts about two hours; the boat is then well smeared with earth oil and allowed to stand for about six hours.

Thingan boats treated in this way are said to last for 25 years.

Thingan is also very good for house building, the timber in houses fifty years old showing no signs of decay. In Mergui it is seldom used for this purpose because a duty of Rs. 15 per ton is charged on it, and many cheaper timbers being available the people prefer to use these. The timber is also used for roof shingles, cartwheels and furniture. It makes almost as good shingles as teak. The Burma Railway has been supplied with a large quantity. The tree yields a yellow resin, which is sometimes used in varnish. Burmans use it in painting pictures. It is ground into a fine powder when dry and mixed with the paint; it is said that pictures painted with paint in which thingan resin has been mixed keep their colour much longer than they would otherwise. It is also mixed with ink for the same reason. The resin is also used for caulking boats; for this purpose it is said to be better than Pwenyet, the product of the dammer bee. It is not largely used for any of the above mentioned purposes, as the systematic tapping of thingan trees is not allowed.

The local price of round timber is Rs. 40 per ton; sawn timber is sold at Rs. 60. From 300 to 500 logs could be exported annually from here if the timber could be worked out.

It is, however, very hard to get contractors to work out timber in these parts, elephants being very scarce and the use of buffaloes for dragging being unknown.

Forestry in America.

By H. J.

(*Concluded from page 450.*)

In chapter IX. Dr. Fernow devotes nearly fifty pages to the "Principles and Methods of Forest Policy."

After summarising the principal contents of the previous chapters, the necessity for, and the justification of, the State's interference in forest matters are laid down. The providential functions of the State, as guarding the interests of the future, are performed by direct control, that is, by ownership, and management by its own agents; by restrictive measures, exercising police functions; and thirdly by education.

The first College of Forestry was instituted by the State of New York, 1898, and is administered by Cornell University. Among the most efficient means of education are *experiment stations:* the State alone can afford to conduct extensive investigations that must be continued for scores of years under systematic organization, and such experiment stations are obviously best utilized when worked in connection with educational institutions. A still more far-reaching influence, also of an educational character, is properly exercised by the State in securing and publishing *statistical information.*

These statistics would refer first of all to the use made of the soil.

All culturable soil should be devoted to systematic food production and the absolute forest soils to systematic wood production: certain forests too exercise a potent influence on cultural conditions, so that topographical location and its relation to the hydrography of the country are important to know.

To get an idea of the amount and value, present and future, of our forest resources we must know the composition, consistence, constitution and condition of the forests, and especially the conditions and stages of development of the young crop. The commercial side too is important, though a statistical investigation of market conditions or of the requirements of wood-consuming industries offers no great difficulty. Lastly, the methods of forest management as well as the condition of the resource call for *statistical inquiry.*

The Federal Government of the United States has lately inaugurated through the Forestry Bureau a system for the encouragement of organized forestry, which consists in giving private owners specific advice as to the management of their forests; the Government bearing the greater part of the expense of these working-plans.

A discussion of the principles of the State's taxation of forest properties, of export duties, and of the State's responsibility with regard to protection against forest fires and other injuries, and finally, a discussion of the right of the State to interfere in the management or mismanagement of private forest properties closes the chapter.

Chapter X is devoted to the forest policies of foreign nations, and shows an intimate acquaintance, both professional, and administrative, with the forest policies of all the principal forest growing countries.

The past history and the present state of forestry of the following countries is given at some length, though in a condensed but interesting form:—France, India, the British Colonies, Russia, Austria, Italy, Switzerland, Sweden and Norway, and lastly Germany, to which country thirty pages descriptive of German forests and their management are devoted.

Chapter XI relates to the forest conditions of the United States. The actual area under forest is given roughly as 500 million acres, but this area has for the most part already been worked over and the marketable timber of the better kinds extracted. The productive forest area is about 26 per cent. of the whole country.

The Federal Government started forest reservation so lately as 1891, and has now reserved some 60 million acres, which however includes a good deal of scrub jungle, grazing land and desert, and even so only amounts to a little over one per cent. of the public domain.

The State of New York owns near $1\frac{1}{4}$ million acres with the avowed purpose of increasing the acreage of State forests, but the majority of the States have not yet begun to acquire State forests. In 1880, there were 200 million acres in the hands of private owners, mostly agriculturists, but much of this area has since passed into the hands of wood-working companies.

Of late years a tendency has developed in the timber trade, as in other industries, to consolidate forest properties, and to form trusts, which now own some millions of acres of forest land. Such trusts, controlling large areas under uniform and continuous policy, may prove, next to Governments, the best agencies for practising forestry properly organized for continuous business.

Of the 500 species of tree growth in the American forests not more than 100 are useful. The most important are the conifers, commercially called "soft-woods" to distinguish them from the broad-leaved species or "hard-woods."

In order of importance the chief kinds are:—White pine, Spruce and Fir, Hemlock, Long leaf pine, Short leaf and Loblolly pine. Among the hard-woods, the oaks are the most

important, followed by the ashes, hickories, maples, the tulip tree, chestnut and other kinds.

The principal supplies of timber are in the white pine forests of the Lake States, and the yellow pine forests of the Gulf and South Atlantic States.

The Atlantic forest is principally composed of deciduous species, with a small mixture of conifers.

The burning question in connection with the protection and working of the United States forests is the forest fires, which are most destructive. The standing timber, the young growth, the accumulated leaf-mould, the fertility of the soil, are all destroyed: the timber supplies have thus been decimated, and the protective function of the forest cover on the mountain slopes very considerably injured, producing denudation, droughts and uneven seasons.

The last chapter of Dr. Fernow's book gives a history of the forestry movement in the United States.

The first official recognition of the necessity of a forest policy was in 1876, when the agency out of which grew the Division of Foresty, now designated as Bureau of Forestry, was established in the United States Department of Agriculture. This bureau prepares working-plans for private owners, and two million acres have thus been dealt with.

In April 1882 the American Forestry Association was formed, and it has become the centre of all private efforts to advance the forestry movement. It publishes a monthly journal, now called *Forestry and Irrigation*, and is quite unaided by Government.

New York was the first State (even before Federal Government), to inaugurate the policy of forest reservation, as well as to make the first effective forest fire law (1885), and further took the first steps to provide technical education in forestry by establishing in 1898 the New York State College of Forestry, to be administered by Cornell University, together with a demonstration area of 30,000 acres in the Adirondacks.

Pennsylvania, next to New York, has most progressed in forestry, and Michigan comes third. The most complete forest fire law is that of Minnesota, 1895, but the reduction of forest fires appears now to depend chiefly on education and development of morals, which must come in time.

The Division of Forestry in the United States Department of Agriculture has now, for the last 25 years, been the official centre of the forestry movement, and together with the American Forestry Asscoiation has largely moulded public opinion.

The principal result of the influence of these two agencies towards a federal policy was the inauguration of forest reservation.

In 1891, an Act was passed by Congress by virtue of which in 1894 seventeen forests with a total area of $17\frac{1}{2}$ million acres were reserved within the three years following.

These reservations were established usually upon the petition of citizens in the respective States and after due examination, the Forestry Association acting as intermediary.

In 1897, thirteen more forests, with an area of nearly $21\frac{1}{2}$ million acres, were reserved, but owing to a want of proper forest administration this wholesale reservation met with a great deal of opposition, especially in the Western States, who, however, have later learned to appreciate the wisdom of these reservations, especially in the irrigation districts.

The administration of these reserves is still of the crudest kind, and forestry practice is as yet hardly attempted. The Forestry Division of the Department of Agriculture, elevated to a bureau in 1901, occupies only an advisory position, and is still without administrative functions, though it ought of course to be in charge of the public reserved forests.

Are there any lessons to be drawn from this sketch of forestry in America?

The Indian Forest Service is the largest forestry establishment in the world, and has been in existence much longer than the Forest Department of the United States. Have we progressed as we should have done, and advanced our professional knowledge, or are we paralysed by officialism, or sunk in indifference?

It must certainly strike one as curious that, while in America, where forestry is only just starting, there should be numerous research bureaux and systematic agencies for collecting and publishing statistical information on forest matters, there should not be in the whole of India one single forest experiment station.

Generations of Forest Officers come and go, but very little definite reliable knowledge is accumulated regarding the rates of growth of our principal species, the classification of the soil and climate conditions of the chief forest countries, the age of maturity of our timber trees in different localities, the best methods of ensuring natural reproduction in the more difficult types of forest, and the normal rates of production per acre per annum in our best-stocked forests. Even the life-history of the sal tree appears to be only imperfectly understood, and in one corner of the Continent it is openly declared by some that fire-protection in forests is generally a mistake.

Surely these reflections suggest that at any rate at Dehra Dun if not at all other provincial centres, there ought to be systematic and continuous experiments made in all these subjects.

No doubt the Department is always undermanned, and the Government vastly prefers its officers to be engaged in revenue

work than in technical research, since the latter yields no immediate return; but we must feel that we have duties to our own profession as well, and a share to take (in our own quarter of the world) in those experiments and researches which are year by year being made in France, Germany and America.

To the Forest Research Bureau we require an office attached for the collection of statistics and data of all kinds regarding the Indian forests and the principal species they contain.

At present, a large proportion of all the knowledge and experience gained is generally lost again. Much information no doubt is buried in working-plans, which are most often not accessible except to officers in the circle to which they apply. Personal observations and the results of desultory experiments may often be embodied in stray reports or sometimes in the *Indian Forester*, but even so these records are not generally available nor easy to find afterwards.

What we want is a central office, where data of every description would be collected from reports, working-plans, and memoranda of all kinds, and the results of all sample plots, enumeration surveys, yield tables, etc., catalogued and compiled so as to be permanently on record and easily available to everyone. A collection of photographs of forest crops, drawings and models of engineering works, would also be useful.

At present very insufficient record is often kept of our sample plots for rates of growth, for results of thinnings, etc. The same applies to plantations. In order to profit by experience, there should always be a large-scale map kept, and the annual results of all sowings and plantings placed on permanent record in full detail; nor is it sufficient to state simply success or failure, as it is the suspected *reasons* for the failure that it is important to record. The means of communicating ideas between different divisions, circles and provinces, too, are at present insufficient. Why should the most successful methods of planting deodar in Jaunsar, for example, be unknown and unheard of in the Punjab? May not the Central Provinces too have something to learn from Burma regarding the working of teak? Compare the New York *Forestry and Irrigation* with our own *Indian Forester*.

It was not long ago suggested in the *Forester* that a special officer should be detailed to undertake the collection of all data relating to the commercial side of our work, and to this might well be added the collection of samples of forest produce and specimens of economic products.

As time goes on, if we are to hold our own in the profession we shall certainly require more specialists, and the time has already come when we ought to have a separate working-plans branch, under a Conservator who would also be Superintendent of Working-plans.

Notes on the Forest Nursery and Plantations in the Panch Mahals.

BY R. S. PEARSON, I.F.S.

I VENTURE to write the following notes on plantations, partly with the hope that they may be of interest to some of the readers of the *Indian Forester*, and also hoping that some brother officer, with more experience, may pull me up where I have gone wrong and give me the benefit of his advice on this subject.

The nursery in question is situated in the compound of the forest bungalow at Godhra, and for the purpose of supervision the site could not have been better chosen.

The bed area is 1 acre 9 gunters, containing 280 beds, 1⅜ yards wide and 12 yards long.

The water is obtained from a common "koss" well some 40 feet deep, and is raised into a tank 22 feet above ground level. From this tank runs an iron pipe into the centre of the nursery, which is tapped by a hose carrying the water to all points of the garden.

The whole plantation and nursery are comparatively new, and the outturn of seedlings, chiefly teak, has varied between 20,000 and 30,000 at a yearly cost of roughly Rs.800, including upkeep of nursery and transplantation in the forest.

In 1901 the question was raised as to the advisability of maintaining this nursery, as the cost was heavy compared to the outturn. It was, however, pointed out that the possibility of the nursery was never reached and that three times the number of plants could be produced at practically the same cost. I was therefore allowed a further trial before the nursery was condemned as a failure. The result was not as good as expected, partly owing to inexperience and partly to a slice of bad luck. Roughly, 100,000 plants were transplanted from the seed beds and doing well in July 1902. Then came a four weeks' break in the rains. After the first week orders were given to water the plants, and on the 2nd day the canvas hose split, though a comparatively new one, and not till 14 days later was a new one obtained. The result was disastrous, as 50,000 plants died, and at the end of the year only 45,000 seedlings were transplanted out into the forest. Had the well been nearer the nursery, wholesale irrigation might have been carried out, which would have saved the situation.

This year there are about 75,000 plants transplanted and about 20,000 still remain in the seed-beds to be dealt with. The rain has been good, but cockchafer grubs have appeared and have done some damage. The beds have been dug up with three-pronged hand forks and the grubs collected, which has to a great extent stopped the damage.

As regards the method employed to quicken the germination of teak seed; it is put into pits 10 feet square and 2 feet deep. It is then flooded with water and left in the pits for 3 or 4 days, and then taken out and dried in layers of about 1 inch thick on the paths. This process is repeated 3 or 4 times, till the outer shell is soft and the seed on the point of germinating. It is then sown in the seed-beds at the commencement of the rains. About 25 per cent of the teak seed germinates in the first year, and it is only in the second year that the seed-beds really produce seedlings in large numbers. I hope some forester will put me on the right line and tell me of a better method of making teak seed germinate in the first year, as two years of germination means two sets of seed-beds and consequently loss of land.

The teak seedlings are transplanted from the seed-beds in August when they have three pairs of leaves. If transplanted earlier they often die; and, on the other hand, if transplanted later the taproot not infrequently gets damaged while being lifted, with the result that the plants wither before being able to catch on to the soil.

Khair (*Acacia Catechu*, Willd.) and ain (*Terminalia tomentosa*, W. & A.) are also grown in the nursery. The germination of both is easy to effect, the only precaution taken being to sow the ain seed on a bed of mixed leaves and straw. This practise saves many of the seeds from rotting from excessive moisture and does not retard the germination. Ain is always transplanted, and khair is either sown straight into the beds or transplanted. I prefer the former method for khair, as in transplanting seedlings they not infrequently die, especially if small.

The beds are watered every 8 to 10 days during the dry season, and at the end of the year, after the break of the monsoon, the one-year-old seedlings are planted out in the forest. The Panch Mahals forests consist chiefly of 30 years' coppice-with-standards. The work is therefore confined to planting up blanks which contain not unnaturally poor soil. The last two years' plantations have been, however, fairly successful, as in the largest plantation made in 1902 only 15 per cent of blanks had to be filled up this year and the old plants are healthy and have firmly established themselves.

The cost of making the poles came to Re. 1 per 1,000 and 12 annas for planting the same number of seedlings.

One of the largest plantations being within 4 miles of the forest bungalow, I had ample opportunity of frequently visiting it during the rains, and I came to the conclusion that the failures were due, to a great extent, to the transplants being small and not vigorous when they were sent out to the forest, and this was especially the case with khair. I examined the roots of plants

that had failed, but could find no trace of insect or fungus having damaged them.

The reason for weak plants having been produced in the nursery was that the soil had been impoverished by taking out successive crops of seedlings and never improving the soil. This year the nursery has been well manured before transplanting operations commenced. A mistake was, however, made with this manuring business, as the heaps of manure were left lying for some time on the paths, while the beds were being prepared, and they acted as collecting grounds for the cockchafer grubs.

In the plantations made this year, the soil in the blanks being extremely poor, 15,000 seedlings were planted with a handful of manure each, at a total cost of Rs. 4. If any benefit is derived from this addition of manure the result will be seen next year, when the manured and non-manured plants standing side by side are compared.

My idea of manuring the small seedlings was to help them in establishing themselves during the first year, after which they get their roots down and can better take care of themselves. The question of plantations in dry regions, such as the Deccan and the Panch Mahals, has been much discussed at various times. Some foresters have condemned such works, while others believe that good results can be obtained at a reasonable cost. Personally I feel sure fair results are obtainable even on very middling soil, with a limited rainfall, provided that strict supervision is exercised by the superior officer, especially during the critical times of transplanting in the nursery and out into the forest, and also the difficulty of making a plantation a success will become less with years of experience and careful observation.

"Double-barrelled" Bamboos.

BY C. E. MURIEL, I.F.S.

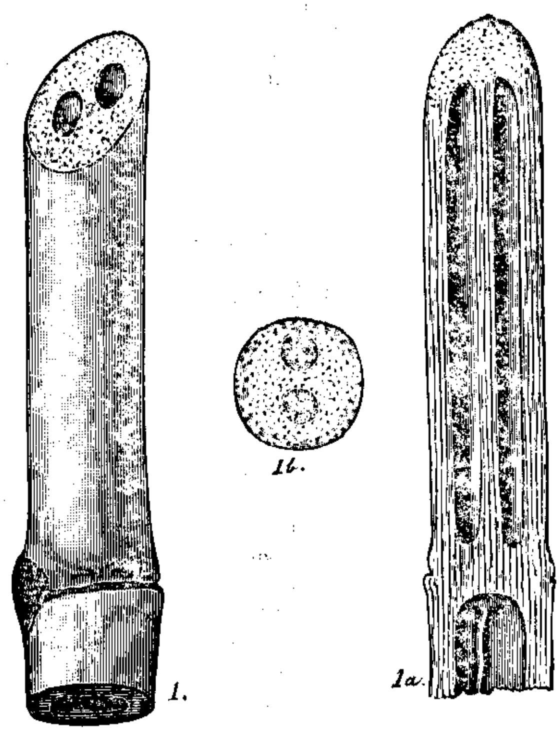
SOME two months ago (July) I noticed some cut bamboos (*Dendrocalamus strictus*) 10 miles north of Pyinmana with double hollows at their upper ends, and since then I have investigated further specimens.

The lower portions of the culms are of the crdinary type of *Dendrocalamus strictus* found growing in fairly moist forest, but in some cases a partition is formed longitudinally some 15 to 20 feet from the ground.

The partition appears to commence as a filament growing longitudinally between the nodes, sometimes straight and in other instances developing spirally. This is succeeded by a straight partition across the bamboo, which thickens in the higher internodes until the upper portion of the bamboo becomes quite solid.

There is nothing in the external appearance of the bamboo to indicate the double hollow.

The sketches accompanying this note may help to explain the appearance of the partition.



1. 1b. 1a.

Specimens of bamboos with partitions are not infrequent in forest some 10 or 12 miles north of Pyinmana, and could be obtained for any person interested in them.

I have sent some specimens to Mr. Gamble (to whom I had written when I first found the double-barrelled bamboo, and who tells me that he had never seen an instance of such growth* during his long experience in India), to the Director of the Imperial Forest School, Dehra Dun, and to the Director of the Burma Forest School.

* In the absence of Major Prain, I M.S., on tour we submitted Mr. Muriel's sketches to Captain Gage, I. M. S., at the Royal Botanic Gardens. Captain Gage informs us that he has never heard of the occurrence of the double-barrelled bamboo and that there are no specimens of it in their Collections.—HON. ED.

The Flowering of Bambusa polymorpha

"WATHON'S" letter in the June number of the *Indian Forester* requested a discussion on the subject of the operations to be undertaken when the *Bambusa polymorpha* flowers to promote teak reproduction. I would accordingly venture to give a few views on the subject.

We wish to take advantage of the general flowering of this bamboo over large areas to help in the natural reproduction of teak, and where such natural reproduction is deficient, to introduce teak seedlings in patches scattered over large areas, and as we are unlikely to have unlimited funds at our disposal for this work in order that large areas may be undertaken, our operations must be done as cheaply as is consistent with efficiency,

The selection and method of treatment of the patches into which teak is to be introduced will require very careful consideration. Let us first consider what happens in the case of deserted *taungyas* cut in Kyathaung forest. Whether these taungyas have originally been cut in old taungya sites or in virgin forests, the year after they have been abandoned they get covered with a dense growth consisting chiefly of weeds and rank grasses with few or no bamboos. After 3 or 4 years the bamboo has again established itself on these areas, unless in cases where the taungya has been cut on both sides of a fairly high spur or ridge, when as a rule the bamboo, while re-establishing itself on the slopes, is unable, at any rate for a good many years, to re-establish itself along the top of the ridge, and in its place on the high ground we get a growth of coarse grass.

Taking the above into consideration, it would appear that whether we cut down the bamboos or not before the bamboo seed ripens on the areas that we wish to operate on, we are certain to find that heavy weeding operations are necessary during the year following the introduction of the teak seed and probably for several years later in addition to whatever weeding is necessary during the year of introduction. In fact if this method were

adopted for the treatment of our areas, the cost would probably be as much per acre as is the cost of our present taungya plantations, and even if the cost were not considered prohibitive for extensive operations, it is doubtful if the trained staff could adequately supervise the subsequent weeding operations over scattered areas.

Let us now for further consideration divide the forest in which *Bambusa polymorpha* is the prevailing bamboo into three classes as follows :—

(*a*) Forest as a rule not very moist and where teak is plentiful.

(*b*) Forest somewhat moister than in class (*a*), teak fairly plentiful.

(*c*) Moist forest, teak scarce or absent.

Class (*a* practically never escapes being burnt over by the annual jungle fires ; class (*b*) suffers somewhat less from these fires, being moister ; and in class (*c*) large areas often escape altogether being burnt over.

Natural regeneration of teak is, as a rule, good in class (*a*) although the seedlings suffer considerably from fire. In class (*b*) the natural regeneration of teak is usually fair only ; the forest, being less open and the soil richer than in class (*a*), teak does not seem to spring up so well from seed as in the former class. In class (*c*) where teak occurs natural regeneration is usually poor or absent altogether, and the introduction of teak into forest of this class is, I presume, what should receive our chief attention when the Kyathaung flowers.

As regards the operations to be undertaken to promote or introduce teak into the forests at the time of the flowering of the bamboo, I would suggest the following :—Operations to be undertaken only in fire-protected areas or in areas that can be brought permanently under fire protection, commencing with the year in which the bamboo flowers.

In class (*a*) if there is a fair crop of seedlings on the ground, except strict fire-protection no further measures should be necessary. The seedlings should from the first dominate the young bamboos and weeds that spring up when the Kyathaung stems die ; but great care must be taken, if necessary with additional interior fire lines, to prevent fire getting into the area.

In class (*b*) if teak seedlings are on the ground a similar treatment should suffice with the addition that to admit more light a number of the inferior species mixed with the teak should be girdled or otherwise killed.

Class (*c*) will require most careful attention. In this class of forest there is, so far as my experience goes, as a rule, a fairly dense leaf canopy, and a good many of the trees continue in leaf the whole year round. The soil is usually rich - generally a good sandy loam—and if teak were ever indigenous it was driven out; and in my opinion if teak is introduced it will be driven out unless we are prepared to take continued measures for its protection. Teak, so far as I have seen, when found in this class of forest, occurs in patches generally on the higher ground (which might possibly point to it being the remnant of the older type of forest) and its regeneration is poor. Even where enough light is admitted to the soil for the growth of teak seedlings, these will rarely spring up.

As we will have to take continued measures for the protection of teak when established in forest of this description by killing species that encroach upon it, it would seem preferable to seek to introduce it into a few large areas rather than into numerous small patches, as it is difficult to manage adequate inspection of scattered patches with a limited controlling establishment, and the advantage of scattered patches is doubtful unless they can receive sufficient attention. Accordingly, as in such forest there is little danger of our exterminating other species and gaining an unmixed teak forest, I would select for treatment areas, say, half a mile upwards in length and 80 to 100 yards broad running along the tops of spurs and ridges.

To introduce teak into such selected areas—as cutting the bamboo would involve heavy expenditure and as a considerable outlay on weeding is certain to be necessary later—instead of cutting the bamboo I would towards the close of the hot weather (having carefully fire-protected the area during the hot season) when all the bamboo seed has fallen, burn the whole area together with adjoining areas unless these are rich in teak. This ground fire should kill off a large proportion of the bamboo seed, and having burnt the area I would dibble in teak seed in lines 9 feet apart. Teak nurseries should be established on the areas undertaken and transplants put in when necessary during the first year. Also before burning the area a large proportion of the inferior species should be girdled, or if necessary felled to admit more light. During the following year the young teak will require assistance from the growth of bamboos and weeds, and I would weed them in lines, say, 6 feet wide, leaving a line of weeds 3 feet wide between each weeded line. One weeding only during the first year following the operations and none during subsequent years might suffice, as usually the greater proportion of the teak dominate the surrounding weeds after the first weeding of their second year.

Forests of class (*a*) and class (*b*) in which there was no teak might be treated similarly to the above ; but in my opinion

if teak is present and there is no natural regeneration it should be sufficient to break the ground slightly here and there in the vicinity of teak seed-bearers to promote the germination of the seed which falls from them without having recourse to fire, but subsequent operations to free the teak seedlings from the surrounding bamboo growth will probably be necessary. In teak areas when natural regeneration is absent, experiments should be started at once to see whether breaking the soil near seed-bearers is sufficient to promote the germination of the seed. After the dead bamboo stems fall, the danger from fire for about the following two years will be very serious, and to guard against this in the areas operated on we shall have to make our fire protection a little more elaborate with numerous interior fire lines dividing up the areas treated.

Operations conducted somewhat as suggested above should cost little as compared with the cost of our present taungya plantations, and if we succeed in establishing teak on the higher ground in moist Kyathaung forest, in after years when the teak so established begins to produce seed, with seed-bearers on the higher ground, by here and there judiciously killing inferior species on the lower ground to admit light, and if necessary breaking the soil in patches, it should be possible at a very small expenditure to extend the growth of teak over a yearly increasing area, and furthermore it should be possible to regulate the percentage of teak as compared with the other species in the resulting mixed forest; but this will be work for a later generation of foresters.

18th September 1903. "KWE-TU-WET-TU."

Our neglected Commercial Side.

So striking an instance of the necessity of some such bureau as that advocated in an article published under the above title in the June issue of the *Indian Forester* has come to my notice that I forward this note without apology.

Some months back, at the instance of the Conservator of the Circle, I initiated enquiries regarding the exploitation of and the trade in sabai grass (*Ischæmum angustifolium*, locally known to the Uriyas as "Babuli"). I was compelled to trouble 2 or 3 Forest Officers of another presidency where this grass yields a considerable revenue, and all most courteously furnished me with valuable information. I further had a quantity of grass collected as an experiment and the grass was sent to a paper mill. The venture resulted in a dead loss, but supplied useful data for further guidance. Within 15 days of completing the transaction, happening to look through some back volumes of the *Indian Forester* (the property of another officer), I came across an article on

"Bhabar grass and the trade in it" in Vol XIX (September 1893). This article over the signature of Mr. J. S Gamble is a *résumé* of some reports submitted by several Divisional Forest Officers and among them one from this very district.

On referring back to old records I now ascertained that not only was a detailed enquiry made and data obtained, but also an experimental supply similar to my unsuccessful attempt of this year was carried out, without any greater success, so far back as 1886.

So in 1903 we are exactly where we were seventeen years ago!

CHATRAPUR, GANJAM DISTRICT. C. E. C. FISCHER.

III.—OFFICIAL PAPERS AND INTELLIGENCE.

The Treatment of Hardwickia Binata.

I SEND the enclosed for favour of publication, in the hope that its perusal will provoke criticism and discussion and thereby lead to a solution of the puzzle which the treatment of the forests of *Hardwickia binata* certainly is to Foresters who have had the good or bad fortune to work them.

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* See advertisement sheets.—HON ED.

Gamble (*Manual of Indian Timbers*, pp. 276-7) says: "Its reproduction is good; it gives a profusion of seed, and the seedlings spring up quickly, but, like those of teak, sal and other Indian trees, are killed to the ground-level year after year in the season of hot winds, until finally the roots get far down into moist strata and the shoots are strong and big enough to grow into trees. The saplings, however, never seem to grow thickly, but prefer to be separated for some distance, even when there are no, or few, other species of tree in the interval. It *coppices well*." The italics are mine and I should like Madras Foresters, who have actually worked the tree as coppice, to corroborate the statement thus italicised. As regards reproduction by seed, I wish anjan seedlings were like those of sal, for then we should have absolutely no difficulty in working our anjan forests here in Berar. It is a very very far cry indeed from sal, which *reproduces itself without any trouble on the part of the forester*, to anjan.

CAMP CHIKALDA, BERAR; E. E. FERNANDEZ,
22nd August 1903. *Conservator of Forests, Berar.*

Letter No. 352 *(Camp), dated the* 19*th August* 1903, *from E. E. Fernandez, Esq., Conservator of Forests, Berar, to the Divisional Forest Officer, Buldana.*

I have the honour to address you in reply to your letter No. C/48, dated the 11th May last, on the subject of the manner of exploiting anjan.

2. While on tour with you and Rai Bahadur Mansukh Rai in Geru-Matargaon Reserve in December 1901, I pointed out to you (i) that experience in the Nimar Division of the Central Provinces had proved that anjan does not lend itself to the coppice treatment proper; (ii) that pollarding had been adopted with apparent success for the production of firewood in that division in those localities in which that tree, as in Berar, does not attain a large size, and (iii) that we have still to discover by experiment how to utilise in an effective manner the periodical gregarious seedlings of the species.

3. Again, in my letter to the Inspector-General of Forests, No. 230 (Camp), dated the 3rd January 1902, which was published in the Proceedings of that officer, I wrote as follows:—

"*Anjan forest.*—This is here a most unsatisfactory type. The species is incapable of attaining the dimensions of sawyers' timber, and can at most furnish house-posts. But the worst point about it is that there has been *absolutely* no reproduction for at least 20 years. After each seeding numbers of seedlings come up, but all disappear before the end of the ensuing hot

weather. The tree will moreover not coppice. The treatment of the type is hence for the present a puzzle, and only tentative methods can be adopted until we hit upon the right one."

4. Lastly, when with you in January last, I informed you that in view of our absolute ignorance regarding the proper treatment of the species, I had decided to include all anjan areas in the category of "unworkable" in the working-plan now under preparation for your division, the object of such inclusion being to leave us a completely free hand to put to the test every practicable method of treatment without the delays (fatal to the success of such experiments) that would be inevitable in the event of our having to refer each time to higher authority in respect of each change contemplated.

5. It is obvious that during this experimental stage we ought not to work on any extended scale, if we do not wish to run the risk of permanently injuring the forest or at least of throwing back considerable areas for a long series of years in the event of the tentative methods proving to be altogether unsuitable. For this reason I am strongly opposed to your proposal to work through entire coupes at a time.

6. You wish to begin at once pollarding on this scale. In regard to pollarding there are two principal points to be established by experiment, *viz* :—

(i) The maximum girth up to which a tree if polled will produce strong *erect* shoots, not merely a bunch of thin *weeping* shoots like those which come up on stools cut close to the ground.

(ii) The maximum height down to which a tree may be polled while still being capable of throwing up such erect shoots. It is obvious that the lower we can cut the trees, the better will be the yield of wood and the better the class of forests that will result.

7. Until we gain more or less certain knowledge in regard to these two points, we must content ourselves with experimenting in a few, well-distributed sample plots, representing different gradients and every class of soil and subsoil. Four-acre plots will be large enough for the purpose. In each sample plot the polling will be effected at various definite heights, from a minimum of $1\frac{1}{2}$ feet rising by 6 inches at a time, to a maximum of $3\frac{1}{2}$ feet. It would not be possible to cut higher than this without very great inconvenience and waste of time. You will be careful to see that the stems cut at one and the same height represent in more or less equal proportion all girth classes commencing at a minimum of 16 inches (the lowest marketable girth for firewood) and rising by 4 inches at a time to the thickest individuals standing in the plot. To secure this equality you should, before proceeding to

fell, girth all the anjan trees in the plot 16 inches and upwards in circumference at $1\frac{1}{2}$ feet from the ground, and at once record the results in a bound register in the manner shown below :—

Characteristic number of girth-class.	GIRTH MEASURED AT $1\frac{1}{2}$ FEET FROM THE GROUND.		Enumeration.	Total number of stems in each class.	NUMBER POLLED AT				
	Not less than	And under			$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$
					Feet from the ground.				
	Inches.	Inches.							
I	16	20	卌 卌 卌 卌 //	22	5	5	4	4	4
II	20	24	卌 卌 卌 卌 卌 ////	29	6	6	6	6	5
III	24	28	卌 卌 卌 卌 卌 卌 ///	33	7	7	7	6	6
IV	28	32	卌 卌 卌 卌 卌 卌 卌 /	36	8	7	7	7	7
V	32	36	卌 卌 卌 卌 //	27	5	5	5	6	6
VI	36	40	卌 卌 卌 ///	18	3	3	4	4	4
VII	40	44	卌 卌 ////	14	2	3	3	3	3
VIII	44	48	卌 //	7	1	1	1	2	2
			Total ...	186	37	37	37	38	37

Having ascertained the number of stems in each girth-class, it will be easy to effect an equal distribution, as shown in the last five columns above. As each tree is measured, the characteristic number of its girth-class, together with its serial number, should be at once marked on it, with white zinc paint, between 1 and $1\frac{1}{2}$ feet from the ground. In one and the same plot these numbers should, for easy recognition, be painted on one and the same side of the stems, say, all on the east or, if on a slope, on the lower side of the slope. They should be repainted as often as they *begin* to be illegible. With the stems numbered thus, all subsequent proceedings will be rendered easy and systematic.

The statement prescribed above will constitute the first entry for the plot to which it relates, all subsequent measurements, countings and other observations being recorded below it in chronological sequence.

8. In November each year each sample plot will be carefully examined and the results observed recorded as just directed above under the following heads :—

A. Year of observation.

B. In respect of all the stumps of each girth-class polled at one and the same height complete data as under :—

(*a*) Number of stumps not bearing any rigid erect shoot at all.

(*b*) Number of stumps bearing only one such shoot and for the entire class the minimum, mean and maximum distances of this shoot from the top of the stump, together with the minimum, mean and maximum lengths and girths (at 6 inches from its insertion on the stump) of the shoot.

(*c*) Number of stumps bearing two such shoots and for the entire class the minimum, mean and maximum distances of the shoots from the top of the stump, together with their minimum, mean and maximum lengths and girths (at 6 inches from their insertion).

(*d*) Number of stumps bearing three such shoots and, as above, for the entire class the minimum, mean and maximum distances of these shoots from the top of the stump, together with their minimum, mean and maximum lengths and girths.

(*e*) The same information for stumps bearing more than three such shoots.

In the course of perhaps less than five years the information thus recorded will enable us to decide with certainty at what height the trees should be polled in order to give the best results.

9. This valuable knowledge will at once receive its practical application in the event of our failure to discover a method of securing with absolute certainty a complete new generation by means of seed alone. Indeed, in view of the fact that anjan seedlings take a great many years to reach the stage at which rapid upward development begins, it is for consideration whether we may not have to adopt pollarding as a practical working system and have recourse to reproduction by seed only as a means, first of filling up the, at present, rather open crops, and, then of keeping up a constant fresh supply of good material for future pollarding. The local demand in the case of anjan is exclusively for house posts and for firewood. Pollarding will produce stems quite thick enough for the former purpose, and a pollarded forest will return a very much larger yield of firewood than a seedling forest. Again, we cannot forget the fact that at its best anjan in Berar will never furnish large timber.

10. The beech in Europe, like the anjan in India, will not coppice after a certain early age. The result is that in many parts of France and on the Swiss side of the Jura Mountains it is subjected to a peculiar system of pollarding technically known in French as *furetage*. It will be best described by supposing that we have, to begin with, a crop raised entirely from seed and hence composed of trees consisting each of a single stem. In order to get it coppice, this crop must be cut young. At this initial stage the trees may, of course, be felled close to the ground as in ordinary coppice, and it is obviously advisable

to do so, save for very urgent reasons to the contrary. But now comes the difference. Many, if not most, of the stools will throw up more than one shoot, and the majority of these, beech enduring heavy shade well, will survive until the next felling. As the object of *furetage* is to create and maintain a forest composed of individuals consisting each of a clump of several stems starting from as near the ground as possible, all the subsequent fellings must perforce leave the original stool or *stump untouched, the shoots to be removed being cut sufficiently* high above their base so that the stump left may be able to throw up fresh shoots. The necessity of doing as little damage as possible to the stems to be left standing (see immediately following sentence) also obliges the woodman to cut well above their point of insertion those he has to remove.

The felling rotation is short (8—12 years), and at each exploitation only those stems are removed which have attained the minimum exploitable girth, so that contrary to what takes place in the coppice method, the crop is never clear-felled. Thus from the second exploitation onwards the forest consists of clumps of shoots of various ages and sizes standing on one and the same original stock.

11. There is no reason why *furetage*, applied consistently with the cultural necessities of anjan in Berar and the requirements of the local demand, should not prove to be not only entirely suited for our forests of that species, but even the only possible method of working them. The system of complete "rest," combined with the exclusion of fire and grazing, has now been tried for the past 30 years without any result whatsoever as regards reproduction, and this policy of expectant passivity must now give place to cultural activity. On the zeal *and intelligence with which you carry out the experiments* ordered in paragraphs 7 and 8 above will depend how soon we shall be able to organise our anjan forests on an effective working basis and at length obtain some utility from them beyond that of occasional grazing grounds. If, as the outcome of our experiments, *furetage* is adopted, even their value as grazing grounds will be considerably enhanced, for in forests so treated, as the rotations are necessarily short and the forest is never clear-felled, the greater portion of the area can remain open to cattle. As Boppe says in his excellent work on sylviculture, "In the Cevennes, in Savoy and in Switzerland, in fine everywhere, the system of *furetage* has been evolved wherever it was found necessary to reconcile pasturage with regeneration by coppice." If we adopt a rotation of ten years, the most promising shoots left standing for three rotations will be large enough to furnish ordinary house-posts, and if thicker pieces were required, the strongest shoots still in full vigour of growth could be maintained up to the

6th, 7th or even higher rotation. Anjan not developed directly from seed becomes fully fertile long before its 20th year, so that under *furetage* effective seed-bearers would, contrary to what happens in clear-felled coppice, be *never* wanting anywhere.

12. As regards the third point stated in paragraph 2 above, I cannot do better than send you the annexed copy of my letter No. 347 (Camp), dated the 16th instant, to the address of the Conservator of Forests, Central Circle, Madras, and in connection with paragraph 5 thereof to ask you to undertake the following experiments:—

I. You will select and permanently mark off three 1-acre plots, one on level ground, the second on a gentle slope and the third on a fairly steep slope. In and around each plot there should be a sufficiency of fertile anjan trees to sow its entire area when a gregarious seeding takes place. In each plot you will, in a year of gregarious seeding just before the seed begins to be shed, have square patches dug up on the square pattern 20 feet from centre to centre either way. The soil in each plot will be loosened to a depth of 1 foot and completely freed from grass and grass roots. One-third of the patches will be 8′×8′, one-third 10′×10′ and the remaining third 12′×12′. In the immediately ensuing rainy season every patch will be weeded once in the last week of July. Half of them will be weeded a second time in the last week of August. At the first weeding the respective total numbers of seedlings in the patches of the three different sizes will be counted and registered. The counting will be repeated on 1st November, 1st February and 1st May during the first year, and on 1st July and 15th January in the subsequent four years. The data collected during these five years will probably give us all the information we require. At the last counting the height of the seedlings should be measured and the minimum, mean and maximum heights recorded.

II. In the third year following the appearance of the seedlings a certain number of them, not less than 100, will be transplanted in different ways between the lines of patches and the results observed during the subsequent two years recorded in full detail in respect of each method of planting adopted.

III. As some anjan trees are to be met with every year in fruit, where small groups of such trees are found you will have a few patches 10′×10′ similar to those described under (I) above prepared in the midst of, and around, the groups and carry on observations as prescribed under that experiment. There will be three such experimental groups, one on level ground, another on an easy slope and the third on a fairly (not too) steep slope.

13. It is hoped that the result of the experiments prescribed in the immediately preceding paragraph will be to show us how to turn to the best account both the annual sporadic seeding and the periodic gregarious fructifications of anjan.

14. I need hardly add that unless the experiments ordered in this letter are carried out systematically and in the proper scientific spirit of enquiry, they will be worse than useless, as they must inevitably lead to the formation of erroneous and even dangerous judgments. I say nothing of the time and labour that would be thus wasted. It does not, however, follow that the instructions conveyed in this letter are not liable to be modified during the course of the experiments, for circumstances that cannot now be foreseen and progressive acquaintance with the conditions of the problems to be solved will most certainly call for altered, if not entirely new, lines on which the investigation should be conducted. In no case, however, ought you to adopt any change of method or subject without previous reference to, and the full concurrence of, this office.

Letter No. 347 *(Camp), dated the* 16*th August* 1903, *from E. E. Fernandez, Esq., Conservator of Forests, Berar, to the Conservator of Forests, Central Circle, Madras.*

I owe you humble apologies for having so long delayed to reply to your letter No 554, dated the 15th April last, in which you ask me to give you my experience with regard to the sylviculture of the *Hardwickia binata* in the Central Provinces. The reason for the delay is that we are ourselves engaged at present in trying to resolve in a practical manner the question of the sylviculture of this tree here in Berar, and are no further advanced now than we were when we took it up 20 months ago on my starting enquiries preliminary to the preparation of a working-plan for the forests of the Buldana Division. On that occasion I wrote as follows to the Inspector-General of Forests on the subject:—

"*Anjan forest.*—This is here a most unsatisfactory type. The species is incapable of attaining the dimensions of sawyers' timber and can at the most furnish small house-posts. But the worst point about it here is that there has been absolutely no reproduction for at least 20 years (I should have more correctly said 30 years), although there has been abundant seeding every 3—5 years. After each seeding numbers of seedlings come up, but all disappear before the end of the ensuing hot weather. The tree will moreover not coppice. The treatment of the type is hence for the present a puzzle, and only tentative methods can be adopted until we have hit upon the right one."

2. In the Central Provinces there are, so far as I could judge, two distinct subtypes of anjan forest according as the underlying rock is sandstone or trap.

3. On sandstone the tree attains to magnificent proportions, reaching a height of 80—100 feet, with a clean cylindrical bole of 40—60 feet and a diameter of 7—12 feet. Such is the case in Punasa and Chandgarh in the Nimar district. In the former forest, when I saw it for the first time, nearly 30 years ago, seedling reproduction had been making excellent progress, for in most places (save, of course, where the soil and situation excluded the species altogether) the seedlings were numerous enough to produce a fairly dense forest if all of them grew up to the dimensions of trees. Up to the reservation of Punasa, only a few years previously, every attempt, as Colonel Keatinge, who had ruled over British Nimar as Political Agent, has left on record, had been made to get rid of the forest and replace it by field crops, but the forest reappeared almost as fast as it was destroyed. To one acquainted like yourself with the system of cultivation followed in those days by the semi-savage tribes of the Nerbudda valley, it is superfluous to say that the ground was never completely cleared of forest, numerous trees of seed-bearing age were left scattered all round and over the fields. The seed fell from these trees on the newly broken land, now at last also freed to a great extent of grass, and the resulting seedlings came up under the most favourable condition for survival. The subsequent cultivation of the soil, limited to a mere scratching of the surface, left an appreciable proportion of the seedlings uninjured to continue their development, and as the field was abandoned as soon as the soil showed the first signs of exhaustion, the young plants were left in complete possession of the ground. In this connection I cannot do better than quote from my letter to the Inspector-General of Forests already cited :—

"As already explained above, we have still to devise a means of saving a sufficient proportion of the myriads of seedlings that make their appearance at each periodic fructification of the species. There is no doubt whatsoever that the death of the seedlings is due to their inability to force their long slender taproot down deep enough through the matting of grass roots occupying the soil everywhere to a depth of 1—2 feet. Experimental sowings made by me in Nimar showed that the anjan seedling develops in its first three months, if not impeded in its growth, a taproot more than 6 feet long in order to reach the permanently moist layers of the soil and thus obtain sufficient moisture to continue its vegetation throughout the trying period succeeding the cessation of the rains, and to start back into full vegetative activity during the height of the ensuing hot weather. In the Punasa forests in 1874, when I took over charge of them, I found the most perfect new reproduction wherever there had recently been field cultivation. In this year the tree seeded with its usual profusion and in the ensuing rains the ground everywhere was so covered with its seedlings that it was impossible to put one's foot down anywhere without stepping on one or more

of them. In October the seedlings began rapidly to wither, and by the middle of the hot weather there was scarcely a single one alive, the inability of the taproots to penetrate through the dense mass of grass roots was the cause of their death. Hence the only thing that will save a sufficient proportion of the future crops of seedlings that are bound to appear after the several successive fructifications will be to do something whereby they may be able to get their taproots down into the permanently moist layers of the soil. The experiments that will be prescribed in the plan will have this end for their objective."

During the 7 years that I was able to continue my observations before I was transferred to the United Provinces the seedlings of pre-reservation days continued to strengthen themselves and develop, but no new contingent of seedlings survived to swell their numbers, and in my inexperience and under the influence of the erroneous idea, unfortunately still very generally prevalent, that the exclusion of fires and cattle was the one panacea for all our forest ills, I attributed the death of the new seedlings exclusively to the annual conflagrations lighted by incendiaries, who thought that they would by such means compel us to abandon conservation. We are now wiser, for we have learnt that more than 20 years of successful fire prevention have given us no better results. The seedlings are as usual produced in countless numbers after every periodic gregarious seeding, but, being unable to push their taproots down deep enough, they all perish in their very first year.

4. On trap the anjan is a very small tree and has quite a different habit of growth. Moreover, besides the periodic gregarious seedings, a few trees here and there, scattered or in small groups, are to be met with every year in fruit during the interval. Nevertheless reproduction is no more successful here than in the sub-type growing or sandstone. Indeed, the chances of survival on the class of trap affected by the anjan are less favourable than on sandstone, which always offers numerous deep fissures for the downward development of the taproot of the seedlings.

5. I feel certain that my diagnosis of the reason of the failure of anjan to reproduce itself from seed is absolutely correct, and that the only remedy for it is to devise some practical and therefore necessarily cheap method of keeping down the grass at numerous points not too far apart from one another in anticipation of a gregarious seeding. I would encourage as much as possible grazing while waiting for this event, and then in the immediately following dry season prepare properly distanced patches at least 10′ × 10′ in size for the reception of the seed. If necessary, I would supplement the naturally fallen seed by sowing with the hand. The patches should be weeded once to keep the soil in them sufficiently free for the rapid downward

extension of the taproots of the seedlings. As anjan bears transplanting well, I would utilise superfluous seedlings from the patches from their third year onwards (younger seedlings would not be robust enough) to fill up the intervals between the patches. An ideal method would, of course, be to grow agricultural crops on the ground up to, and including, the seed year, but it would be impossible to find a sufficient number of persons complacent enough to take up the cultivation on the condition of clearing out at the end of the rainy season immediately following upon the fall of the seed. Grazing must, of course, be absolutely excluded until the young crop is tall enough to be safe from injury.

6. Before deciding to write this letter I asked our old friend, Mr. T. B. Fry, now in charge of the Central Forest Circle, Bombay Presidency, to give me the benefit of his long experience of the anjan in that Province. A copy of his reply is annexed. At the same time I would ask you kindly to favour me with your own experiences and views.

Letter No. 1558, *dated the* 11*th August* 1903, *from T. B. Fry, Esq., Conservator of Forests Central Circle, Bombay Presidency, to the Conservator of Forests, Berar.*

In reply to your letter No. 312 of 3rd intstant, I have the honour to say that our experience regarding the natural reproduction of anjan appears to be much the same as that which you have described as taking place in Berar. The tree seeds more or less irregularly every year and abundantly every third or fourth year, but in spite of this one never finds a dense growth of saplings. Throughout Khandesh and Nasik, where the tree is fairly abundant in parts, I have almost invariably noticed that the trees are dotted about singly 20, 30 or more feet apart. In our case fire and grazing may have had something to do with this, especially in Khandesh. If we could protect seedlings from these two dangers, I believe that many more of them would survive, though possibly the open nature of the forests in which the anjan grows may have something to do with the great mortality among the seedlings. Perhaps they cannot stand the fierce hot weather to which they are exposed, and something might be gained by introducing nurses.

V.—SHIKAR AND TRAVEL.

The Indian Pheasants and their Allies.

By F. Finn., B. A., F. Z. S.

(*Continued from page* 420.)

Chapter IX.

QUAILS.

The partridges being now disposed of, we come to the quails, under which heading, as I said in the introduction, are included all the smallest members of the pheasant family, having the closed wing under five inches in length. The term, like "teal" among the ducks, is somewhat conventional, for just as some small ducks, such as the whistlers, are called "teal," though their relationship to the proper teal is obviously small, so some of the "quails" are evidently tiny partridges rather than close allies of the typical quails. Whatever their real relationships may be, the ten little game birds which are popularly known as quails are separable as follows :—

The *Mountain quail* by having the tail well-developed, nearly as long as the closed wing; other quails having very short *tails.*

The *Stout-billed bush quails* (2 species) by their thick, short bills, and short but well-formed tails about half as long as the wing.

The *Slight-billed bush quails* (4 species) by having ordinary bills and well-formed tails about two-thirds as long as the wing.

The *Typical quails* (3 species) by having no noticeable tail at all, the tail feathers being not only less than half as long as the wing, but so soft that they are not easily distinguished from the ordinary plumage of the rump.

It should be noted that the so-called Button quails or Bustard quails do not belong to the pheasant family at all, but form a curious little group of their own, the Hemipodes, which *will be dealt with at the close of this series.* They have the same soft tails as the typical quails, but differ from them and from all other *Phasionidæ* in having no hind-toe,* no web at the base of the toes, and only a single row of scales down the front of the shank. The head has also a quite different expression from that of ordinary quails, the bill being longer and the eyes yellowish white.

* The Australian Plain Wanderer (*Pedionomus torquatus*) has a hind toe and some Australian Hemipodes have short stout bills, but the above characters will diagnose all Indian species.

The typical or soft-tailed quails fall into two sections, one containing the common Japanese and Rain quails, with the sexes not very different and about a dozen feathers in the tail, and the other the little painted quail, in which the male and female are extremely unlike and there are only eight tail feathers. The plumage in these quails is marked conspicuously with light streaks above, and there is no spur in either sex, though this does not prevent the males from fighting furiously. They live always on the ground, and are more or less migratory.

The Common Quail.

Coturnix communis, Blanford, Faun. Brit. Ind., Birds, Vol. IV., p 114. Native names:—*Bater*, *Bara bater*, *Gagus bater*. Hind.; *Batairo*, in Sind; *Batri*, Bengali; *Gundri*, Uriya; *Soipol*, Manipuri; *Botah Surrai*, Assamese; *Bur-ganja*, *Gur-ganj*, Poona and elsewhere; *Burli*, in Belgaum; *Gogari-Yellachi*, Telugu; *Peria-ka-deh*, Tamil; *Sipale haki*, Canarese.

Both sexes of this species are much alike, the plumage being a mixture of black, brown, and buff, streaked with cream colour; there is a conspicuous cream streak down the crown and eyebrow stripes of the same colour. Below, the plumage is buff, darkening into reddish brown on the flanks, which are spotted with blackish, and boldly marked with whitish streaks. The pinion quills are brown, with buff bars on the outer web. The bill and eyes are dark and the feet flesh coloured.

The male has the breast without spots, and the throat dirty white with a dull black mark shaped somewhat like an anchor, the shank running down the centre of the throat and the arms curving up on each side. The female has the throat plain whitish, but the breast is spotted with black. Although there is a good deal of variation in tint in this quail, Indian specimens are on the whole true to colour, though some males occur with a rusty ground colour on the throat; in Europe this, and even the marking, is more variable: and this part of the plumage may be entirely dark or rusty brown. This quail is about eight inches long, with the wing, which is longer in proportion than in any other bird in the family, four to four-and-a-half inches; the shank is about an inch long. The hens run longer than the cocks, though the difference is not striking. The weight is between three and four ounces.

This is the most widely-spread and thoroughly migratory species of the present family; it is found over most of Europe, Asia, and Africa, breeding in the northern parts of its range and moving southwards in winter. Great numbers are caught on migration and many must perish at sea; I remember, ten years ago, I saw one poor little thing try to board a ship I was on in the Red Sea, and, striking the side, fall into the water. Another, less utterly exhausted, was caught on board and

ultimately reached the London Zoological Gardens. Most of our Empire is visited by this bird in winter, but it is most abundant in Northern India, rare in Burma, and absent from Ceylon and Tenasserim. Some come by sea on to our Western coasts—Sind, Cutch, and Guzerat—but most cross the Himalayas from Central Asia, and these arrive earlier.

Their distribution with us varies with the season they encounter on reaching India. If there is plenty of food in the north, most of them stay there, but in years when the crops are deficient there, they move southward to a greater extent; moreover, in some years a great many more birds arrive than in others. In the Calcutta bazaar during the seven years I have watched it, quails only came into the ordinary bird-sellers'* hands one winter, about two years ago if I remember aright; then the men had plenty of them, and they were reported as being unusually common in Bengal. Ordinarily only one man in the Calcutta bazaar has quails, and he gets the birds from up-country and keeps and feeds them for months, being a resident and considerable dealer, unlike the men who only come in the winter to sell birds more or less locally captured.

The quails come in across the sea from the west before the end of August, and about a fortnight later the main body from the north arrive. At the end of February they begin to draw northwards again, and if the south of India has not come up to their expectations, the north will be full of them in March. Some will linger in the south for a time as others had done in the north, but in any case hardly any will stay behind permanently and breed with us.

They migrate at night as a rule, though stray specimens may be seen, at sea at any rate, by day. Mr. Hume describes how on one moonlight night in April a few miles from Mussoorie, a huge cloud of them, "many hundred yards in length and fifty yards I suppose in breadth," passed over him quite low down. That the quail is more or less nocturnal I have little doubt. A specimen which I kept years ago in my rooms at Oxford was quite as active by night as by day, whereas ordinary birds will go to roost in a room quite irrespective of the artificial light of lamps or gas. For the same reason quails are very unsuitable inmates for a mixed aviary, unless they have a wing cut, as they will get restless at night and fly up against the roof, to the detriment not only of their own personal appearance, but also of the peace and happiness of the other inmates of the place.

A special place for quails, where these birds may be kept for food, should, however, it is said, be kept dark to prevent their

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* Quail were very plentiful round Calcutta in December-January, 1899-1900, good bags being made in a couple of hours' shooting. The birds were also plentiful in the Dun (N. India, in the autumn of 1900 and spring of 1902. —HON. ED.

fighting. The floor of a "quailery" should be well supplied with sand, and fresh turf, white ants occasionally, and a constant supply of water in a small trough should be provided in addition to their ordinary food of millet. Thus treated they will keep fat and healthy, and, as many people know, be of the greatest use in the hot weather As they are even better to eat when properly fattened than when killed wild, it is not only humane but politic to treat them as well as possible, as is the case with all other animals in a state of captivity or domestication.

The natural food of this quail is millet and other grain when it can get it, and at other times grass-seed and small insects chiefly; it feeds chiefly in the morning and evening, resting in the middle of the day. Here and there a few pairs remain and breed with us, even in the east as far as Purneah and south in the Deccan. These, however, are not of a resident strain or race, such as exists in some other countries which quail also visit as migrants, but birds which by some accident, such as one or both of the pair having been wounded by shot, have been unable or unwilling to depart with the rest of their kind.

Though the male has the reputation of associating with several females where the species is numerous, he appears to pair with one only in India; the nest is a mere hollow in the ground, usually with more or less of a lining of grass. In India ten eggs appear to the largest clutch, though up to fourteen may be laid in Europe.

These eggs are a little over an inch long, and are speckled with brown on a buff ground, the markings varying a good deal. They may be found in March and April. In the latter month this bird was observed to be breeding abundantly about Nowshera in 1872, which was an exceptionally backward year, so that the quail had evidently decided in many cases to make the best of things where they were and not go north, since they should have all been out of India a month later in the ordinary way.

The cock quail is a pugnacious little wretch, and is often kept by natives for fighting, as he used to be also by the ancient Greeks. The latter used, besides setting the birds at each other, to indulge in an even more feeble sport, which consisted in putting one's bird in a ring when the other player tapped it on the head with his finger, and won the game if the bird ran out of the circle.

In Calcutta I have now and then seen in the quail cages a bird of a lurid red ochre hue, evidently stained with some dye: and I am told on good authority that the said dye is nothing more or less than the saliva of a *pan* chewer, smeared on the luckless bird to stimulate its courage; certainly such an application would infuriate a white mouse, I should think! Presumably the bird which, after this doctoring, permits itself to be defeated is frugally

sold as an edible; but after this I rather draw the line at red quails in that capacity. In China the unhappy quail is said to be brought to an enhanced state of irritability by baths of hot tea.

The note of this quail is unmistakable, being a distinct tri-syllable, *the first note being the longest;* many attemps have been made to render it in words, such as "Wet my feet." This is only uttered by the male, but some small chirping notes are emitted by both sexes.

Their haunts are in crops and the stubble of these, grass, bush jungle, any low cover in short, and they afford more good *shooting than any other bird of this family in India. Their flight* is low, straight and swift, and one has been seen to escape from a harrier by sheer speed, but then a harrier is not a very swift hawk. They are often very unwilling to rise, and I have even heard of one being trodden upon, which is what one might call falling a victim to a policy of *laissez-faire.*

The Lumberman and the Forester.*

By Gifford Pinchot,

Forester, U. S. Department of Agriculture.

It is only a few days since President Roosevelt, speaking to the Society of American Foresters, a body of professional foresters, said that in the final analysis the success of forestry must depend upon the attitude of the lumbermen toward it. [*Vide* p. 301 of this volume.—Hon. Ed.] That view is accepted and believed by no one more completely than by the foresters, and it is, first of all, for that reason that I am glad of this opportunity to say a word to you. I realize that the great majority of the timber lands of the United States will pass through your hands first or last, and that upon your attitude toward them will depend the final result, not only to you in your business, but to the nation at large in the perpetuation of its forests.

One of the recent tendencies in the lumber business has been to reduce waste in every possible direction. You have taken this up first of all in the mill; it has gone from the mill to the woods and the methods of logging, and in many parts of the country has already begun to affect methods of cutting. This tendency to avoid waste, to make better use of natural resources, is not confined to the lumber trade by any means. It is characteristic now of all the industries of the United States, and is the logical outcome of the economic situation, just as, in my belief, the interest of the lumbermen in forestry must necessarily be the logical outcome of the economic conditions under which the lumber business is placed. You have naturally and logically moved forward step by step in this progress of eliminating waste, making more out of the material with which you have to work. It is perfectly logical and natural, therefore, that the next step for you to consider is the use of your standing timber, not merely for itself alone, but also in relation to the value of the land to you later on. That is the whole essence of forestry. As President Roosevelt has phrased it, "The principal idea in forestry is the preservation of forests by wise use," and the conception upon which the whole matter is based is simply the question of whether or not you intended to get a second crop.

The old idea that the forester was the enemy of the lumberman, and, above all, the enemy of cutting timber, disappeared long ago from the minds of foresters, or rather friends of forestry—for no true forester ever held it—and is rapidly disappearing from your minds and those of other lumbermen. And that is perhaps the happiest aspect of the whole situation, for the perpetuation alike of your industry and of forestry depends upon

* Address delivered before Convention of National Lumber Manufacturers' Association, Washington, D. C., April 20, 1903.

stop short as soon as the course of technical instruction was completed. In the event of anything being done, it should be incumbent upon the State to provide positions in which those foresters who had successfully passed through their studies could advantageously utilise their knowledge so as to warrant the expenditure of public money for educational purposes. Any attempt to solve the problem of British forestry cannot be satisfactory unless it is carried out in a wholehearted manner. No amount of mere tinkering will assist the matter one iota, but would give rise to much dissatisfaction amongst the public, who would look upon it as a useless expenditure, unless some really permanent and profitable object was to be attained, and any adverse attitude would probably end in a retrogressive movement, causing any effectual solution to be postponed indefinitely.

Any extensive improvement of British forestry can only be accomplished by forestry becoming a great State industry. To any one who has given serious thought to the question this is a foregone conclusion, as no individual efforts on the part of private persons can ever succeed in giving the country a reliable supply of timber in large enough proportions. It is the aim of those persons who have the question most at heart to place the country in a position independent of foreign competition as far as coniferous timbers and those hardwoods which can be grown to perfection in our climate are concerned, and the only way in which this can be done is for forestry to be conducted on commercial lines absolutely controlled by the State, with the exception of those woodlands already in cultivation by private owners, which, by the way, if improved, would act as a welcome supplement, although their present unsystematic condition renders them scarcely worth consideration. The astounding fact that there are 21 million acres of waste land in the British Isles is a standing disgrace, reflecting adversely upon all our national, political and social economic systems. The future historian as he turns to this fact will be amazed at the immense and paradoxical folly of our times. Our overcrowded towns glutted with a superfluity of both skilled and unskilled labour, our depopulated rural districts deserted for the towns and arid wastes and barren plains of far-off countries, will present to him a mysterious and inscrutable problem, particularly as we have within our reach a natural mine of wealth totally unexploited not only capable of giving employment to a great new rural population, but with untold commercial possibilities.—*Timber Trade Journal.*

your attitude toward this single question: Do you or do you not intend to get a second crop?

I am very far from wanting to discuss with you the supplies of standing timber or the prospect of a timber famine—questions with which you are more familiar than I am; but it is perfectly obvious that the supplies of certain kinds of timber are rapidly disappearing, that the lumber trade is falling back year by year on poorer material and longer hauls, and that the question of its *continuance is already demanding an answer*

This is purely a business proposition which I want to lay before you, to be considered, accepted, or rejected on a business basis. Forestry deals with the forest in some ways with which you have but an indirect interest. I am not talking now about the effect of forests on the flow of streams, on winds, or on the general prosperity—matters of vital importance in their place; but the question I want to bring to you is simply this: Is it worth your while, from a commercial point of view, to consider the forest as a part of your plant, and from that point of view should you cut off your timber and let the land go back for taxes?

Let us take an illustration. Suppose any one of you has a tract of timber land in Arkansas, for example—for we have some good figures for that State. You find that under certain conditions, which make practically no difference in the cost of getting out your logs—and it is the business of the Bureau of Forestry to ascertain what those conditions are—you can get a second crop of the same amount off that land in forty years. It will be a man's tendency, as it was mine when I began this work, to think of forty years as a very long time, a period beyond ordinary calculation, hardly worth while to figure on. Nevertheless, if I interpret the economic tendency of the country at all rightly, men look farther ahead now than they once did, and it is very *well worth their while* to do so. We *will* say that in forty years you can get a second crop on that land equal to the first. We take the stumpage at its present value, with taxes as they now stand, and we estimate the expense of protection against fire and theft. We find in this particular case that the returns on the capital invested for those forty years is 6 per cent. net. That is calculated on the basis of the present value of stumpage. We all know that the value of stumpage will increase largely in forty years. The matter becomes, then, simply a question of whether or not it is worth your while to take the incidental risks and hold your land for forty years rather than to put your money into something else. But it is not a question of whether you will put the money back into your land after taking the timber off of it, but whether you will take the timber off in such a way that when you have cut over the land it will be in condition to go on producing timber without further expense. Either the timber land is part of the manufacturing plant, or it is not, and that is the whole difference.

If you are the owner of a mill, as of course you all are, you must necessarily consider, if you want to keep that mill in permanent operation, how much land you need to grow timber to supply you with your daily cut. Then you have a complete plant which is like a machine shop, turning out material for its own needs. From the point of view of the forester, where a business question is as clear cut as that, it becomes as foolish to destroy the productive capacity of your land as it would be for the owner of a machine shop, when he had an order for a shaft or a cog wheel, to take that shaft or cog wheel out of his own machinery and sell it rather than make his machines produce it. As I have said, and repeat, this is purely a business question.

The Bureau of Forestry offers certain assistance to lumbermen in preparing the basis upon which such questions can be most intelligently decided. What it does is simply to put a certain amount of trained skill at your command. You pay the expense and we prepare for you the necessary figures. The way we do it is to send a man to the spot, who finds out what there is on the ground, with special reference to the smaller sizes—how fast each diameter class of trees grows, how much will be left of certain sizes after cutting out others, and how much will be standing to the acre after a definite number of years. We put the thing purely and entirely on a business basis.

These methods of forestry are not at present as fully applicable everywhere in the United States as they will be later on, and it is as far from me as possible to want to urge any man to adopt the methods of forestry unless they are going to pay. The arrangement we make with timber owners is never that they shall be compelled to apply the plans we submit, but always that they shall apply them or not as they find it wisest to do. I would be exceedingly sorry if any man should take up a proposition in forestry and apply it if he was not confident it would turn out well, because this is not a question of a few days or merely for present conditions.

What I have been describing to you is, of course, only one of the ways in which the Bureau of Forestry is attempting to serve the lumber interests of the United States. Another is a very extensive series of timber tests which we are just taking up to learn the comparative merits of different timbers for different purposes: and there are many others, some dealing directly with the lumber interests and some indirectly. But the essence of what I have to say to you to-day is simply that this matter of practical forestry is presented to you as a business proposition to be accepted or rejected as a business proposition, and that my interest in it and the object of my presence here is simply to ask you whether it is worth your while to consider your forests as a part of your plant or whether it is better worth your while to abandon them after they have been cut.

I shall be very glad, indeed, if I can answer any questions which may come up now or later on, and I shall be especially glad if I or any other member of the Bureau of Forestry can be of use to you, individually or collectively, in any possible direction. There has been too long a feeling that the foresters were trying to force the lumbermen to do something or other against the lumbermen's will. I think it is time for the lumbermen to give the Bureau of Forestry a chance to do some things which they would like to have it do.

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Notice to Subscribers.

MR. E. P. STEBBING, Honorary Editor, having proceeded on six months' furlough to Europe, Mr. R. McIntosh has undertaken to act temporarily as Honorary Editor until Mr. Stebbing's *return*. All contributions should be addressed to R. McIntosh, Honorary Editor, Dehra Dun, United Provinces.

The Commercial Value of Mhowra (Bassia latifolia, Roxb.) Seeds.

BY G. M. RYAN, F.L.S., I.F.S.

IT might interest Forest Officers in the Bombay Presidency, and also other parts of India, to hear, in case information on the subject has not already reached them, that a brisk demand has just set in in the Bombay market for Mhowra seeds. A certain demand for this minor product has existed, it is true, during the past few years for various purposes, as the *export returns quoted* later on show; but the present demand appears to be quite distinct from the previously existing one, brought about apparently by a discovery in Europe of a new use for the oil from the seeds; and the supply, judging by information obtained in the Bombay market, appears to be unequal to the demand.

A gentleman in one of the leading firms in Bombay, under date 2nd October 1903, referring to Mhowra seeds, says: "We bought only yesterday at Rs. 5-8 per cwt., but this was an unusual price; you may take Rs. 4-8 per cwt. delivered free railway station in Bombay as a reliable rate. Prices of Mhowra seed fluctuate a great deal, but I have never seen them below Rs. 4-4 per cwt."

Another large firm received an order from England on the 3rd instant for Mhowra seeds at £8 2*s.* 6*d.* per ton, but have been unable so far to execute it. Such being the state of things, it seems incumbent on me, with a knowledge of the facts, to make them known, and it is felt that by doing so through the medium

of the *Indian Forester* some benefit might accrue to the State thereby. An eye ought certainly to be kept on the Mhowra seed collections wherever the tree is found in any quantity, and if timely arrangements are made for the Departmental disposal of the produce some additional revenue may possibly be realized in certain localities from this produce. The market value of Mhowra seeds is higher than for myrabolams, and if it is considered desirable in the interests of the State to dispose of the latter minor product annually, why not so with Mhowra seeds?

It might be urged that the collection of seeds will interfere with the local requirements of the people, for almost everywhere oil is expressed from them for domestic purposes; but if the right to collect the seeds is farmed out, or a duty levied on the amount exported from a district, there need be no apprehensions on this score. It might be thought, also, that the collection of seeds will restrict the collection of the flowers—a product which is also an important article of minor produce; but fortunately no apprehensious need be felt on this account also, for it is only the fleshy corolla of the flower which is gathered, the calyx and pistil and ovary being undisturbed. In some parts of India the produce is evidently being collected to a tolerably large extent, judging by the export returns, but no record exists in the Forest Administration Reports of any revenue being realized by the State from it. *

DISTRIBUTION.

So far as the Northern Circle is concerned, I am aware that a large quantity of Mhowra is to be found in the Panch Mahals, for during the severe famine of 1899, when there on famine duty, its majestic form in places was prominently brought to my notice, and doubtless in the other districts of Guzerat, even where no forests exist, such as Broach and Khaira, the tree will be found in fairly large quantities also In the Mandvi Taluka of Surat it is abundant.† In Khandesh the tree is fairly common on the Satpuras and Satmalas.

Sir Dietrich Brandis, in his work *Forest Flora of North-West and Central India*, says: "It is cultivated, propagating itself by self-sown seedlings, and protected in most parts of India. In the Panjab it is grown in the Sub-Himalayan tract and the outer valleys as far as the Ravi, but not commonly in the plains; abundant in all parts of Central India from Guzerat to Behar. There seems no doubt that the tree is indigenous in the forests of the Satpura Range of Western India above Ghat and perhaps also of Eastern Kaman."

* In the Central Provinces Mahua and Achar are shown in Form No. 58 as having been exploited in 1900-01. Mahua is possibly *Bassia latifolia* but what Achar is I do not know.

† It *was* abundant 20 years ago, and the number of trees may have been reduced since, but about this I have no information at present.

Mr. Talbot in his book *The Trees, Shrub, and Woody Climbers of the Bombay Presidency,* says: "It is common in the dry forests throughout the Presidency, also in the *Konkan and North* Kanara forests, but nowhere abundant in them." In Thana it grows to advantage in the drier parts of the districts, away from the seacoast, the best specimens being found perhaps in Murbad and the Mokhada Petta—a tract of broken hilly country about 2,000 feet, which forms the western projection of the Ghats. The tree, which is familiarly known as Moho by the natives all over the district, is scattered in all the forests, *though it is* smaller in size in the Bassein seacoast taluka than further inland. It is never seen lopped for *tahal* for *rab*,* or cut for any other purpose. Hence it is invariably a much larger and more imposing tree than many others, both inside and outside the forests. It attains a height of about 30 to 40 feet and a girth of about 5 feet, and possesses a dark coloured bark, and seems to be of a light demanding habit. It is a fertile cause of forest fires all over Thana, for in order to facilitate collection of the corollas the area under the crown of a Mhowra is cleared of all growth, and *the lazily disposed effect this by burning* the patch underneath, and the fire in most cases spreads into the forest. In spite of notices and orders cautioning the wild tribes against carelessness in this respect the evil continues. The only effective check against this is arresting the offenders and having them prosecuted, and this is commencing to have successful results, judging by the latest returns for fires from this cause in Central Thana.

ECONOMIC USES.

Leaves.—During the famine in the Panch Mahals in 1899-00 the leaves were extensively collected and used as fodder for cattle in that district, especially in the vicinity of large towns. In the Thana District they are used as wrappers for small parcels by small shopkeepers and as dinner plates.

Flowers —The flowers are of a very pale yellow, and appear in March after the leaves have fallen. The corollas shortly afterwards get detached from the calyx and begin to fall to the ground; after this the new flush of leaves, which are ruddy or a *dull* pink and brown appear. It is during the cool hours of the evening, during the night and early morning, up to about 9 a.m., that the constant dripping of the corollas from the trees takes place, and they are extensively collected by the people. In the Mokhada Petta the wild tribes barter the flowers in the Kasara Bazaar on the G. I. P. Railway below the Thull Ghat, for onions and salt. Marwaris obtain the flowers in this manner from the Thakurs and Kolis and export

* *Tahal* is the term used for the branchwood which is cut for burning to provide wood ash manure, and *rab* is the manured plot on which the rice seedlings are raised for transplantation.

them to the distilleries at Uran across the harbour in Bombay.* Three to four baskets of flowers are bartered for one basket of onions and a little salt. The dried flowers are also sold for one anna per basket to contractors' agents. In parts of Wada the people, who are permitted under the Abkari rules to store 2 seers (*i.e.* 4lb) of flowers for household purposes per head, sell their surplus stock to Abkari agents, who come round to make purchases, for ¼ anna per paili of 4lb. Locally the flowers are extensively collected and eaten after preparation in the following manner. They are spread out and dried in the sun for 3 days, after which they are pounded into flour and mixed with similarly prepared kurasni (*Verbesina sativa*) seeds, salt and bread and eaten. The dried flowers are also mixed with the powdered young roots of the Ranshekat (*Moringa concanensis*) in parts of the Wada Taluka and boiled, and the decoction is drunk in colds and chills; cattle are also stallfed on the flowers for augmenting their milk supply and calving and for swollen throat complaints. The spinners and weavers in Bhiwndy eat the dried flowers also with bread.

Bears, it is believed, are fond of the flowers, and I remember an incident occurring in the Khandesh Satpuras many years ago, when my camp was some miles away from a post office, which rather supports this statement. The post never arrived one afternoon, and on the following day when it did arrive, the Bhil who brought it informed me that the failure to bring it the previous day was due to his being obstructed by a bear who sat in the path along which he had to go and prevented him passing. His explanation was that the bear having eaten the Mhowra flowers became intoxicated and wished to attack him. At the time I was rather inclined to discredit the story and have never since received any corroboration of it.

In order to remove the temptation for the illicit distillation of Mhowra spirit in villages, an edict went forth that the tree was to be cut down wherever it existed in Thana, and this has resulted in a large diminution during the past 18 or 20 years in the number of trees in the Thana district. In the coupes the tree is never reserved as a standard on this account, and also because of it being a source of forest fires, as already explained.

Seeds.—The seeds, which are commonly known in the vernacular as *Mohoti*, are ready for collection usually by about the end of May or beginning of June.

As in the case of myrabolams, called Hirda† in the Bombay Presidency, the crop varies in quantity from year to year. Oil

* In 1884 Government undertook the collection of flowers in Thana departmentally for export, and many hundreds of maunds were collected, but in that very year France, to which country the flowers chiefly went, levied an import duty on them, so that the exports were curtailed and the venture proved a great loss.

† *Terminalia Chebula*, Retz.

from the Mhowra seeds is extracted locally all over the district and eaten with vegetables.

Existing sources of supply of exported Mhowra seeds.—The following are the principal sources of supply of Mhowra seed received at Bombay. It has not been possible to get out the figures for each of these stations, as for some years now the railways have included Mhowra seed under the heading "Other Seeds":—

BY G. I. P. RAILWAY.

Central Provinces and Berar.

Hurda.	Stations on the Nagpur Branch.
Itarsi.	Stations on the Wardha Coal State Railway.

N.-W. Provinces

Jhansi.	Banda.
Hamirpur Road.	Mahoba.
Karwi.	Mau-Rampur.
Atarra.	

Southern Mahratta Railway.

Harlapur.

East Indian Railway, *via* Jabalpur.
Oudh and Rohilkhand Railway, *via* Cawnpore.
Bengal & North-Western Railway *via* Nagpur.
Hyderabad Godavery Valley Railway, *via* Manmar.

BY B. B. & C. I. RAILWAY.

Tapti Valley Railway.

Amalner.	Nandarbar.
Fort Songhad.	Dondaiche.
Bardoli.	

Godra-Rutlam Railway.

Dakor.	Godra.
Thasra.	Sunth Road.
Sevalia.	Piplad.

Gaekwar's Dabhoi Railway.

Bodeli.	S. Bahadarpur.

Ahmedabad-Prantij Railway.

Talod.	Idar Ahmednagar.

Rajpipla State Railway.

Nandod.

BY SEA.

British ports within the Presidency.

Firms engaged in the trade.—The following firms in Bombay which deal in myrabolams would probably purchase Mhowra seeds:—

Messrs. Volkart Brothers	Messrs. Begbie & Co.
Messrs. Ralli Brothers	Messrs. Killick, Nixon & Co.
Messrs. Owen and Okell	Messrs. N. Futteally & Co.
Messrs. C. Macdonald & Co.	

Amount of seed available for export in Thana.—Without interfering with the local demands and the amount of seed needed for sowing and planting* if necessary, the quantity of seed available for export would probably be not less than 400 khandies or *say* 2,000 cwt.

Cost of collection.—It pays contractors to purchase the myrabolam crop in Thana and export it at their own cost, and this is done when the present price of the crop is worth Rs. 3-4-0 per cwt delivered Bombay. The Mhowra crop being worth Rs. 4-4-0, it can be easily understood how much more lucrative the transaction would be. Doubtless the value of the produce would fall as the supply increased, but even allowing for this, a profit equivalent to that in myrabolams at any rate will probably result. It is unnecessary to enter into further details so far as cost of collection of seed is concerned under the circumstances, especially when the crop is to be farmed out. In case however contractors are reluctant to enter on this new business, it may be necessary to undertake Departmental work at first, and for this reason the following rates, as obtaining in Thana, and other particulars are given for information :—

Price of Seeds in Bombay :—

	Per cwt. Rs. a. p.	Per cwt. Rs. a. p.
		4 4 0
Cost of collection	1 8 0	
Cost of gunny bags	0 8 0	
Freight at 2-9 per maund for 50 miles ..	0 4 0	
Loss by dryage and wastage, etc, 20% ..	0 8 0	
Establishment 25%	0 11 0	
		3 7 0
Rs.	3 7 0	
	..	0 13 0

Profit say :—

13 annas per cwt. for 2,000 cwt.

13 as. × 5,500 cwts. Rs. 1,635.

Exports from India—Very full and interesting particulars about the Mhowra tree, its distribution and the economic uses of its flowers and seeds may be found by a reference to the *Dictionary of Economic Products.* In that volume, page 414, wherein figures showing the external trade of Mhowra are given the export returns of flowers only is quoted. It would appear that at the time the note was written† (viz. 1883-84) an export trade only in flowers existed and that the trade was mainly with France.‡

* Quite recently some Mhowra seed was collected in Thana for Mr. J. P. Watson, a Bombay merchant, for despatch to South Africa, where he intended to try and grow it on the veldt.

† There may be a subsequent note, but I am not able to trace it.

‡ Mhowra seeds are exported to Hamburg and Antwerp.

Now this trade has almost entirely ceased, judging by the recent returns, for only once during the last two or three years have Mhowra flowers been exported from India, and the quantity was only 93 cwt.

The export trade in Mhowra seeds has been as follows since 1897-98 for Bombay and the whole of India :—

	Bombay. Cwts.	All India. Cwts.
1897-98	not given	255,746
1898-99	138,450	139 389
1899 00	358 083	367,092
1900-01	31,958	31.958
1901-02	597,009	613,549
1902-03	252,668	..

For the sake of comparison the exports of myrabolams for all India are as follows :—

	Cwts.
1897-98	726,060
1898-99	905,916
1899-00	1,018,285
1900-01	945 648
1901-02	1,085,174

Cotton seeds used to be exported from India in small quantities for a number of years, but now, as is well known, the demand has risen very considerably for this product for the manufacture, more particularly, of margarine, it is said ; so that the exports have reached enormous proportions. Let us hope that a similar good demand is setting in for Mhowra seeds (at present at any rate a very good demand exists) and in these days of a declining revenue in myrabolams it behoves us to look around for further sources of profit.

Conclusion.—I am indebted to the courtesy of Mr. Noel Paton, secretary of the Bombay Chamber of Commerce, for the statistical information given above about the Mhowra seed exports. He is a gentleman most interested in the development of new industries, and will be at all times willing, I am sure, to supply Forest or other officers with all the information they might at any time need about the value, etc., of various commercial products.

What should Madras Forests yield?

II.

IN the previous article an attempt was made to show roughly the value of the yield of the Madras forests if they were properly protected and markets could be found for their annual yield.

To deal first with the question of markets; the unproductive forests will only be open to the production of revenue under

compulsion, to meet the demands of neighbouring villages. So far as this class is concerned, the market question presents no difficulty.

The remunerative forests yield principally timber, and as we are constantly hearing about the diminution in the world's supply of timber and the coming timber famine, it may be presumed that the export trade will absorb surplus over internal demand.

The productive forests will, at ¼ ton per acre, yield 10,66,666 tons fuel and small timber annually, and the market for this large quantity must be found in the Presidency itself and within a comparatively small number of miles of the sources of production. In exceptional cases it pays to transport fuel a considerable distance (*e.g.*, casuarina fuel from Nellore can be sent to Madras, a distance of 80 miles, by canal, and sold at a profit), but as a rule fuel will not stand cartage exceeding 12 to 15 miles, while small timber eats its own price if transported by cart for more than thirty miles.

On the other hand, the denudation of unreserved lands is making rapid strides, and the population is becoming more and more dependent on the Government reserves for its fuel and small timber; the large towns, such as Madras, Madura, Trichinopoly and Salem, will before long be entirely dependent on Government forests for fuel for domestic consumption, and the demand for agricultural implements, materials for cart building, fuel for jaggree and indigo boiling, for lime kilns, brick kilns, etc., in every village must be met more and more from the same source. The railways still burn wood fuel, and are likely to continue to do so as long as it can be supplied at prices which compare favourably with those of coal, and as they can dispose of 40,000 tons annually, only 166,666 tons are left to be accounted for by domestic consumption, agricultural requirements and local industries. A very rough calculation will show that if all these local requirements are to be met from the produce of Government forests, not only will there be no lack of markets, but the total quantity available will not equal the demand. At one pound per head per diem every six persons need one ton of wood per annum, and if there were not other sources of supply there would be a dearth of fuel in the land. As the State forests are practically the only protected wooded areas (except private casuarina plantations), it is evident that as years pass the demand for fuel will fall more and more heavily on them, and in order to meet this demand more rigorous protection is required now, so as to improve the stock and increase the annual yield. And this brings up the question of protection. Before the days of Dehra Dun Rangers, the Forest Department was a happy hunting ground for subordinates of all classes; the only bit of leaven in the district loaf was the District Forest Officer, who was unable to check the predations of his subordinates scattered over an area of several thousand square miles; there

were of course exceptions, and happy was the D. F. O. who had at least one trustworthy Ranger under him. Some were merely *lazy and did as little* work as they could, and as some ranges were over a hundred miles in length, neglect of work at any one spot was always accounted for by the Ranger's absence at the other end of his enormous charge. Others were absolutely dishonest, and joined the department with the sole object of enriching themselves, an object easy of attainment when every man's hand was against the forest, and even the local magistrates sympathised with the people who were not allowed to help themselves to forest produce when, where and how they liked, as their forefathers had done before them.

With such an example set by the Rangers it cannot be wondered at that the forest guards followed suit, and the post of forest guard was so much sought after that it was not uncommon for a man to resign a post in some other department on a salary of Rs.10, Rs 12 or even Rs.15, in order to obtain a forest guard's post on Rs.6 or Rs.7. The reverse of the shield must also be taken into consideration ; District Forest Officers had such enormous areas to travel over that they could not supervise and inspect Rangers' work sufficiently often or thoroughly ; Rangers on small pay and with no recognised official position in the taluk could not obtain assistance from village officers in sending messages to guards, etc.; the village officers, being frequently engaged in trade in stolen timber or fuel, threw every possible obstacle in the way of Rangers, who, ignorant and untrained, in charge of areas which even a trained Ranger would find it impossible to thoroughly control, meeting with opposition at every turn and almost sure of punishment for neglect at each of the D. F. O.'s inspections, made hay while they had the chance. The guards' beats extended over as much as 50 square miles of forest, frequently comprising two or three blocks ten miles away from each other ; the guards could not protect such large and disjointed areas, and did not try ; it was much simpler to go the round of the villages and collect eight annas per plough, one goat per hundred, etc., for not seeing them in the reserves, and these annual payments were so considerable that if dismissal closed a guard's career after two or three years' service, it could be taken smiling, putta lands and growing herds acquired during service more than counterbalancing the loss of prospective pension.

The advent of the trained Dehra Dun man has raised the moral status of the Ranger class, and though there are still black sheep in the flock, and occasionally even a Dehra man turns out badly, the improvement, as compared with past years, is most marked, and is bearing fruit in improved protection and increased revenue. To the credit of Dehra be it said that the training there has changed many a youth from a listless, helpless, indifferent subordinate, to a keen, capable and energetic Ranger, who does his

best and does not spare himself in trying to manage an area large enough to keep four men like him fully employed, and in spite of being hampered in his field work by the old class of guard and in his office work by incompetent clerks. Protection of the forest against man and fire is still far, very far, from perfect, and must remain so until each guard has a beat of a size which he can protect and each Ranger has an area so limited that he can make sure that every one of his guards actually does protect his beat.

To arrive at some idea of the establishment required, it is necessary to begin at the smallest unit, the guard's beat. What area can a guard efficiently protect? This depends on the nature of the forest, the formation of the ground, the facilities for patrolling, the vicinity of villages and the location of the guard's house. It is evident that in a high forest in the plains, opened up by roads and inspection paths, a guard can cover a larger area than in a scrub forest full of thorny growth on a rocky hillside, in which neither roads nor paths have been opened. It is evident also that a guard living in his forest can protect a larger area than one living in a village two miles from the boundary of his forest. Conditions vary so enormously that no hard and fast limit can ever be laid down, but there is no doubt that in the present unopened (by roads, paths, etc.,) condition of the State forests a much larger number of guards is required than will be the case some years hence, when guards have been provided with suitable accommodation *in* the forests, and when export and inspection roads and paths have been driven through the forests in every direction. Another element has also to be taken into consideration, namely, *that the population of the country has not yet accepted the fact* that the State forests are absolutely the property of the State, and that theft of trees from a State forest is as much an offence as theft of crops from a neighbour's field; until this is realised, the protective establishment must be exceptionally strong.

In the French forests, with a law-respecting population, with forests thoroughly opened up by roads and paths, with guards' houses in the forests, the average size of a guard's beat is $2\frac{1}{2}$ square miles, and though it may be argued that in the interior of such vast forests as the Nallamalais, which cover 2,000 square miles, such small beats will never be necessary, it must be remembered that, on the other hand, there are numerous small forests of about 1,000 acres in extent, for each of which a guard will be required, and that in many larger blocks, owing to the proximity of villages, beats will have to be below the average in extent. If then in France, with developed forests and law-abiding people, one guard is required for every $2\frac{1}{2}$ square miles of forest, the same average area cannot be deemed excessive in Madras, with undeveloped forests and a law-resisting population (23,749 forest offences were reported during 1901-02).

At this rate 8,000 guards would be required for the whole Presidency.

Next comes the range, the most important unit in the chain of forest control. A Ranger should be able to visit each guard's beat at least once a month; he has also to attend court to prosecute forest cases, to attend to special works in the forests, and to devote a certain time to writing reports and posting returns, etc. Allowing 4½ days for Sundays, 1 day for occasional holidays, 4½ days for office work, 2 days for attending court, 3 days for devoting to special works, a ranger would have 15 days a month for beat inspection, and though in a compact range he might cover two beats in a day, in a range composed of scattered blocks he might find it hard to manage even one beat daily. Fifteen beats would give an average of 24,000 acres or 37½ square miles per Ranger, and 533 Rangers would be required for the Presidency.

Next comes the question of the controlling staff, consisting of Imperial and Provincial officers, who would each have charge of a division, the size of which would depend on the number of ranges a Divisional Officer could control, and whose accounts could conveniently be consolidated in one office. Each range should be visited twice a year at least, some time would have to be spent in headquarters, and some time devoted to special works, such as laying out roads, constructing slides, etc., in the forests. With a centrally situated headquarters, a Divisional Officer might manage 12 ranges, but with ranges scattered over a large extent of country 8 would keep him fully employed. Assuming the average as 10, 53 Divisional Officers would be required, each having 375 square miles of forest under him.

An increase would also be required in the number of Conservators, each of whom should visit each of his divisional charges once a year; nine such charges would fully occupy a Conservator's time, and six Conservators would be required.

A Department of the size sketched above would require a head, and it would be necessary to have an Inspector-General over the Conservators, holding a position similar to that of the present Inspector-General under the Government of India.

The above suggestions may seem as wild and impossible as the calculations of revenue in the former article, but the material to yield that revenue exists or can be called into being by efficient protection, and it is surely worth considering what protection is necessary in order to realise the full value of the State forests and at the same time build up and maintain forests which will be of infinite value in many ways to the country. Naturally the increase in establishment will have to be made gradually, but with a net revenue of Rs. 7,50,000 annually, the time has come when a commencement can be made.

The present establishment costs, in pay alone, and excluding office establishments and temporary establishments charged to works, Rs. 5,48,200, or 22 per cent. of the gross revenue; the establishment of the future as sketched above would cost Rs.16,45,600, or less than 7 per cent. of the estimated revenue; in other words, in order to bring the establishment up to the strength required for the efficient protection and exploitation of the State forests, an increase of Rs. 11,00,000 of establishment is required, which would ultimately result in an increase of Rs.2,15,00,000 of revenue. Is this wild and impossible? Let the Rs 7,50,000 net revenue be devoted for the next seven years, half to increased establishment and half to opening out the forests, protecting them against fire and working them systematically, and then let results speak for themselves.

TSEROPHI.

Fire-protection in the Teak Forests of Lower Burma.

In the March number of the *Indian Forester* Mr. Gleadow did me the honour of making a few comments on a letter I wrote on this subject.

He assumed that fire-protection is oppressive, and on this account makes use of the strong expression "pernicious" with reference to my letter. Our teak forests in Lower Burma were, however, for the most part waste lands and not required by the neighbouring population, but by fire-protecting them the neighbouring population benefits directly by the large sums of money which this work *involves*.

He blames me for not specifying more precise localities than those mentioned in the heading of my letter; but, writing for fire-protection, somewhat illogically thinks it unnecessary to be bound by any localities at all, and brings forward statistics collected in N. Europe for use in India.

There is a hackneyed platitude to the effect that "the conditions of locality" differ, but that forest principles are the same throughout the world, and therefore it is necessary to avoid the prejudice in favour of fire-protection, which is caused by the act that by keeping fire out of the forests of Europe or India a considerable loss is known to be avoided, and to deal with the question in Burma on its merits, *in accordance with sylvicultural* principles.

Through the kindness of the former Editor of the *Indian Forester* I was able to obtain a very interesting but entirely inconclusive discussion on this subject.

The passage which struck me most was: "In forestry, in our *view*, it *is* the mature *opinion of experienced professional* men that is of more value than statistics."

I quote this because it shows the foundations on which our scheme of fire-protection is based, namely, on the mere opinions of Forest Officers, and not on statistics or general information collected through experiments conducted by them.

The opinions of Forest Officers, however, are not unanimous in favour of fire-protection, and even if they were, Mr. Glealow's manner of deciding an important question in Forestry appears to me to be opposed to fundamental forest principles.

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Similarly in scientific forestry, in those countries where there is a staff of trained men, Forest Officers are invariably cautious, not only on account of their reputations, but also because in carrying out sylvicultural operations a large sum of money is always involved.

Before applying any method or theory to the forest on a large scale great care is taken to eliminate all possible errors of judgment, and numerous experiments are first carried out on a small scale to test the proposed method and to clear up all doubtful points and contingencies which might possibly arise. It is, in short, considered essential that the value of a proposed measure should be *proved* before it is carried out on a large scale. The typical instance usually given of unscientific forestry is that of thinnings in England.

Our colleagues there, who are doubtless also shrewd and able men, are almost unanimous in making thinnings too heavy, and by neglecting to obtain sufficient information, make an error of judgment. In this instance it would be possible to obtain information and ready-made statistics from the very similar localities on the Continent, whereas for fire-protecion in Lower Burma it would be necessary for us to collect information ourselves in the usual manner. Otherwise the parallel is, I think, complete.

Although there are numerous doubtful points in connection with fire-protection on which Forest Officers disagree, yet as far as I can find out, not a single experiment has been carried out nor any effort made to collect accurate and convincing proof, and therefore I maintain that we are similarly incurring the possibility of an error of judgment.

As regards the effect of fire or fire-protection on the soil, it is well known that fire does not cause any loss of inorganic matter, but it has been proved from experiments carried out in Europe that fire, by destroying the soil covering, caused a loss of organic compounds. The question arises, therefore, whether teak suffers by this loss.

There is, I believe, no known instance of the growth of teak having been improved by this loss being averted, but it has been repeatedly noticed that a teak seedling thrives best on a well-burnt patch where this loss is greatest. This seems to show that teak either does not suffer by this loss, or that it can obtain nitrogen and other organic compounds in some other manner.

Moreover, the effects of fire-protection are not the same as the avoidance of the loss caused by fire. For example, the leaves which fall annually do not accumulate and form humus in a fire-protected area, but when not destroyed by fire are eaten by termites.

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The extent of the damage done by fire is a question on which there is considerable difference of opinion.

There is a general belief that fire is responsible for a great number of our hollow trees. It is held that when a teak seedling is burnt back by fire, the seeds of decay are admitted into the roots. The base of the taproot becomes swollen, and from it coppice shoots are sent out until one is sufficiently strong to resist fire.

It is laid down that trees grown from coppice tend to become hollow for obvious and intelligible reasons, which do not apply in this case, as the taproot is discarded at an early date in favour of laterally branching roots, and with it the few germs of decay disappear.

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In the case of these inverted V-shaped wounds the marketable value of the timber is in the majority of cases unaffected, only the sapwood and bark being destroyed and not the heartwood, which apparently possesses some matter which renders it more incombustible than the heartwood of other species of tree.

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I noticed a good illustration of the effect of fire-protection in S. Tharrawaddy.

Teak is often found associated with Kyathaung (*B. polymorpha*) and a little Tinwa (*Cephalostachyum pergracile*), but in the fire-protected parts a dense undergrowth of Tinwa seedlings has sprung up, so dense as to kill or prevent the appearance of teak

seedlings, even when the additional help has been given of opening up the canopy by improvement fellings. In the areas not protected teak seedlings are numerous.

The amount of seed of Tinwa is the same in both cases, but in the latter case much of it is burnt by fire, and the seedlings which do appear are constantly burnt back, and where the shade is moderately dense and the vigour weakened thereby, the seedlings are often killed outright.

Teak does not bear a great quantity of seed, and the seed is not fitted with any contrivances to be widely distributed, and therefore it competes at a disadvantage with more favoured species, except that the seed and the tree throughout their lives are admirably adapted to withstand fire, and, therefore, by fire-protection we are taking away the principal means by which teak scores over its rivals.

It is well known that dahs and axes cannot make headway against the luxuriant vegetation of a typical dense teak and bamboo forest, except at a cost which is prohibitive on a large scale, and even if fire caused some damage to teak it has counterbalancing advantages, in that it destroys much useless seeds and plants and overmature trees, and is in reality comparable to an improvement felling. Its usefulness in this manner can be readily realised by sowing teak seed in protected and unprotected areas in every place where it is thought a teak seedling would have a chance of springing up.

The fact that by not spending vast sums of money on fire-protection we should enable more seedlings to spring up is of vital importance, in consideration of the fact that the outturn of the future depends on the natural regeneration of the present.

One of the first effects of fire-protection is that the shade is increased owing to the survival of useless species and their increased germination. This shade is not increased immediately, and when first an area is protected teak enjoys the advantages of both fire and fire-protection.

It is generally agreed that in unprotected areas about ten years elapse before a teak seedling establishes itself against fire, but that when established, the growth is not further affected by fire. On the other hand, teak is well known to be very sensitive to shade, as witness the difference in growth between one grown under shade and one grown in a plantation, and therefore fire-protection, by increasing the shade, causes considerable loss of increment, and it is not improbable that many seedlings are eventually killed.

An examination of the stump of nearly every teak tree shows that at some time or another the tree has been badly suppressed and within an ace of being killed by shade.

Is it not probable, therefore, that fire-protection, by increasing the shade, would in many cases have been the last straw, or that the loss which will ensue by successfully protecting our forests for a long period of time will be considerably greater than that caused by fire?

It has been acknowledged in previous Forest Administration Reports that natural regeneration of teak suffers under fire-protection, and it has been suggested that this state of affairs should be remedied.

It was suggested that after periods of fire-protection reserves should be from time to time burnt over, and at the same time that natural regeneration of teak should be further stimulated by improvement fellings, etc.

It may, however, I think, be urged that if during the period of fire-protection teak benefits, other species will benefit to a still greater extent, and, in spite of an occasional fire, will still continue to oust the teak.

The light manner in which fire-protection has been taken up and the little attention given to a study of its effects is due, I believe, to the very general belief that a protected area can be at any moment restored to its former conditions by ceasing to protect. This belief, however, does not appear to me to be well founded.

Unlike Europe, where it is abnormal for a fire to occur in a forest, in Burma the forests have been burnt over from time immemorial. As fire affects some species more than others, it is obvious that it must have been an important factor in determining the proportion of the different species one with another, and therefore fire-protection upsets the normal balance.

There are doubtless many species whose numbers are kept down by fire, which spring up in great abundance when fire is excluded, in course of time establish themselves against fire, and are unaffected when it ceases temporarily to be excluded. Thus in the example of the effects of fire-protection I gave previously, dense masses of bamboo seedlings have sprung up during a period of fire-protection, and these now are of sufficient size in many cases to resist fire, and many localities have in this manner become almost unproductive of teak.

There are many localities equally suited to evergreen or teak forest. There has lately been some correspondence in the columns of the *Indian Forester* on the subject of encroachments of evergreen forests, and this Sir D. Brandis attributes to the fact that an area must have escaped fire for a year or two. Consequently I think there is reason to expect that under fire-protection encroachments will become numerous and areas rendered unproductive of teak.

I maintain therefore that it cannot be taken for granted that after disturbing the normal balance by fire-protection, the former productiveness of an area as regards teak can be restored by readmitting fire.

There is a further consideration, that even at present fire-protection absorbs the greater part of the working season, and as every teak forest in Burma is to be protected during the next five years, the work will be nearly doubled. We do next to nothing to stimulate natural regeneration of teak now; is it likely that fire-protection in the future will leave us any time to administer its antidote?

Our object in a teak forest is to increase the revenue from teak, and fire-protection must be considered merely as a means to this end.

To increase the revenue it is necessary to increase the quantity of teak.

Fire cannot be said to prevent teak from becoming more numerous, and I have in fact endeavoured to show the contrary; but the competition with other species does. One teak tree alone would suffice in a very short time to stock the whole of Burma were it not for this competition, and therefore the most natural way to increase the future revenue would be to devote our energies towards lessening this struggle for existence instead of at present increasing it. I am inclined to the opinion that the damage done by fire is only, in the majority of cases, secondary, and that it is only when the vigour of a teak tree is affected by causes, such as old age, creepers, suppression, etc., that fire causes serious damage.

If this is the case, the damage can be reduced to a minimum by preventing the *primary* cause of damage. In the future we shall extract trees at maturity, and already we cut creepers, but as far as I am aware no attempt has been made to free trees from suppression. Teak trees are seldom so close that a neighbouring tree cannot be felled without damaging them, or if so close a dense unreserved tree would probably do more damage by remaining than in being felled. When felled it is only the small branches which burn strongly, the larger branches and bole merely smouldering away and causing no damage. There would be also the further advantage that in falling these trees would form gaps, and being burnt, would form suitable germinating beds for teak seedlings. In this and other ways, without incurring the evil effects of fire-protection, the damage from fire would be reduced to a minimum, and we could devote our energies and our money to lessening the struggle for existence and to increase the proportion of teak by direct means.

We all love our teak trees, and are distressed when we see an occasional one blackened by fire, but forestry is not a subject in which sentiment can be indulged.

A large amount of intelligence is not required to suggest fire-protection as a means to prevent the damage from fire, but in forestry it is customary to find out definitely what benefit will be gained and what will be the effect of any proposed measure, and whether the expense is justified.

Some Forest Officers, I understand, who have been sufficiently fortunate in convincing themselves concerning the value of fire-protection, take up a pharisaical attitude about this question, and when any doubt is expressed talk about heresy. I maintain however that since its commencement there always has been doubt, and that, on the principle that forestry is not a suitable subject for speculation, it is unorthodox to carry it out on such a large scale. Instead of attempting to stifle doubt, it would, I think, be preferable to prepare to meet it with reliable and carefully collected information.

At present Forest Officers differ in opinion very considerably.

Our motto is merely to "hope for better things;" but no harm would, I think, be done by definitely ascertaining that we actually are improving our forests by the vast sums of money we spend on fire-protection.

H. C. WALKER.

Charles Broilliard.

BY J. W. O.

MOST of our readers will have noted with regret the recent retirement of M. Charles Broilliard from the editorship of the *Revue des Eaux et Forêts*. The following are some extracts from an account of his work in the Forest Department of France, by F. Fankhauser, which appeared in the April number of the *Schweizerische Zeitschrift für Forstwesen.*

Charles Broilliard was born on the 4th July 1831 at Morey, a small town in Haute-Saône. The cliffs behind Broilliard's home command an uninterrupted view over the borderland between hill and plain, from the domes of the Vosges to the snowclad peaks of the Swiss Alps, and it may well be that the peculiar charm of this richly wooded country early awakened Broilliard's love of nature, and influenced in great measure his choice of the forest service as a profession.

Broilliard entered the Forest School at Nancy in the year 1851. After completion of the school course and the subsequent year of practical work he began his forest career in the summer of 1854 at Briancon in charge of a highland forest division extending

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Although there are numerous doubtful points in connection with fire-protection on which Forest Officers disagree, yet as far as I can find out, not a single experiment has been carried out nor any effort made to collect accurate and convincing proof, and therefore I maintain that we are similarly incurring the possibility of an error of judgment.

As regards the effect of fire or fire-protection on the soil, it is well known that fire does not cause any loss of inorganic matter, but it has been proved from experiments carried out in Europe that fire, by destroying the soil covering, caused a loss of organic compounds. The question arises, therefore, whether teak suffers by this loss.

There is, I believe, no known instance of the growth of teak having been improved by this loss being averted, but it has been repeatedly noticed that a teak seedling thrives best on a well-burnt patch where this loss is greatest. This seems to show that teak either does not suffer by this loss, or that it can obtain nitrogen and other organic compounds in some other manner.

Moreover, the effects of fire-protection are not the same as the avoidance of the loss caused by fire. For example, the leaves which fall annually do not accumulate and form humus in a fire-protected area, but when not destroyed by fire are eaten by termites.

To compare these two modes of destruction. When destroyed by fire there is no loss of mineral matter, and there is the advantage that an extra quantity of mineral matter is often automatically supplied in places where teak seedlings are likely to spring up, such as in gaps caused by windfall trees, and, on the other hand, the loss of inorganic compounds is only of doubtful importance.

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It is not unusual to find statistical information of the power of teak to resist fire, in the shape of badly girdled trees bearing hammer marks some 20 years previous, and proving that a tree of which the vitality is nearly extinguished can resist fire for a long period, and the logical conclusion is that even a moderately healthy tree can offer a greater resistance. Attention is often drawn to the fact that one or more inverted V-shaped patches are often found at the base of many teak trees where the bark and sapwood have been burnt. In a seedling the sap is drawn up equally round the stem, but in a mature tree the sap is drawn up from laterally branching roots and then distributed. The presumption is, therefore, that there are inverted V-shaped patches at the base of each tree between the points at which the roots meet the stem where very little sap flows, and the bark and sapwood being practically dead, are specially susceptible to fire, but if burnt the growth of the tree is not affected, and in fact is only so when the sapwood and bark are so burnt that the upward passage of the sap from the roots is interrupted and the root rendered useless.

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An examination of the stump of nearly every teak tree shows that at some time or another the tree has been badly suppressed and within an ace of being killed by shade.

Is it not probable, therefore, that fire-protection, by increasing the shade, would in many cases have been the last straw, or that the loss which will ensue by successfully protecting our forests for a long period of time will be considerably greater than that caused by fire?

It has been acknowledged in previous Forest Administration Reports that natural regeneration of teak suffers under fire-protection, and it has been suggested that this state of affairs should be remedied.

It was suggested that after periods of fire-protection reserves should be from time to time burnt over, and at the same time that natural regeneration of teak should be further stimulated by improvement fellings, etc.

It may, however, I think, be urged that if during the period of fire-protection teak benefits, other species will benefit to a still greater extent, and, in spite of an occasional fire, will still continue to oust the teak.

The light manner in which fire-protection has been taken up and the little attention given to a study of its effects is due, I believe, to the very general belief that a protected area can be at any moment restored to its former conditions by ceasing to protect. This belief, however, does not appear to me to be well founded.

Unlike Europe, where it is abnormal for a fire to occur in a forest, in Burma the forests have been burnt over from time immemorial. As fire affects some species more than others, it is obvious that it must have been an important factor in determining the proportion of the different species one with another, and therefore fire-protection upsets the normal balance.

There are doubtless many species whose numbers are kept down by fire, which spring up in great abundance when fire is excluded, in course of time establish themselves against fire, and are unaffected when it ceases temporarily to be excluded. Thus in the example of the effects of fire-protection I gave previously, dense masses of bamboo seedlings have sprung up during a period of fire-protection, and these now are of sufficient size in many cases to resist fire, and many localities have in this manner become almost unproductive of teak.

There are many localities equally suited to evergreen or teak forest. There has lately been some correspondence in the columns of the *Indian Forester* on the subject of encroachments of evergreen forests, and this Sir D. Brandis attributes to the fact that an area must have escaped fire for a year or two. Consequently I think there is reason to expect that under fire-protection encroachments will become numerous and areas rendered unproductive of teak.

I maintain therefore that it cannot be taken for granted that after disturbing the normal balance by fire-protection, the former productiveness of an area as regards teak can be restored by readmitting fire.

There is a further consideration, that even at present fire-protection absorbs the greater part of the working season, and as every teak forest in Burma is to be protected during the next five years, the work will be nearly doubled. We do next to nothing to stimulate natural regeneration of teak now; is it likely that fire-protection in the future will leave us any time to administer its antidote?

Our object in a teak forest is to increase the revenue from teak, and fire-protection must be considered merely as a means to this end.

To increase the revenue it is necessary to increase the quantity of teak.

Fire cannot be said to prevent teak from becoming more numerous, and I have in fact endeavoured to show the contrary; but the competition with other species does. One teak tree alone would suffice in a very short time to stock the whole of Burma were it not for this competition, and therefore the most natural way to increase the future revenue would be to devote our energies towards lessening this struggle for existence instead of at present increasing it. I am inclined to the opinion that the damage done by fire is only, in the majority of cases, secondary, and that it is only when the vigour of a teak tree is affected by causes, such as old age, creepers, suppression, etc., that fire causes serious damage.

If this is the case, the damage can be reduced to a minimum by preventing the *primary* cause of damage. In the future we shall extract trees at maturity, and already we cut creepers, but as far as I am aware no attempt has been made to free trees from suppression. Teak trees are seldom so close that a neighbouring tree cannot be felled without damaging them, or if so close a dense unreserved tree would probably do more damage by remaining than in being felled. When felled it is only the small branches which burn strongly, the larger branches and bole merely smouldering away and causing no damage. There would be also the further advantage that in falling these trees would form gaps, and being burnt, would form suitable germinating beds for teak seedlings. In this and other ways, without incurring the evil effects of fire-protection, the damage from fire would be reduced to a minimum, and we could devote our energies and our money to lessening the struggle for existence and to increase the proportion of teak by direct means.

We all love our teak trees, and are distressed when we see an occasional one blackened by fire, but forestry is not a subject in which sentiment can be indulged.

A large amount of intelligence is not required to suggest fire-protection as a means to prevent the damage from fire, but in forestry it is customary to find out definitely what benefit will be gained and what will be the effect of any proposed measure, and whether the expense is justified.

Some Forest Officers, I understand, who have been sufficiently fortunate in convincing themselves concerning the value of fire-protection, take up a pharisaical attitude about this question, and when any doubt is expressed talk about heresy. I maintain however that since its commencement there always has been doubt, and that, on the principle that forestry is not a suitable subject for speculation, it is unorthodox to carry it out on such a large scale. Instead of attempting to stifle doubt, it would, I think, be preferable to prepare to meet it with reliable and carefully collected information.

At present Forest Officers differ in opinion very considerably.

Our motto is merely to "hope for better things;" but no harm would, I think, be done by definitely ascertaining that we actually are improving our forests by the vast sums of money we spend on fire-protection.

H. C. Walker.

Charles Broilliard.

BY J. W. O.

MOST of our readers will have noted with regret the recent retirement of M. Charles Broilliard from the editorship of the *Revue des Eaux et Forêts.* The following are some extracts from an account of his work in the Forest Department of France, by F. Fankhauser, which appeared in the April number of the *Schweizerische Zeitschrift für Forstwesen.*

Charles Broilliard was born on the 4th July 1831 at Morey, a small town in Haute-Saône. The cliffs behind Broilliard's home command an uninterrupted view over the borderland between hill and plain, from the domes of the Vosges to the snowclad peaks of the Swiss Alps, and it may well be that the peculiar charm of this richly wooded country early awakened Broilliard's love of nature, and influenced in great measure his choice of the forest service as a profession.

Broilliard entered the Forest School at Nancy in the year 1851. After completion of the school course and the subsequent year of practical work he began his forest career in the summer of 1854 at Briancon in charge of a highland forest division extending

ever 23,000 hectares. His 2½ years' tenure of this post was spent in making himself thoroughly familiar with the management of the larch and Scotch pine forests of the higher Alps; at the end of 1856 he was transferred to the Upper Doubs Valley, the region of the spruce and silver fir, for the study of which he had ample opportunity during the next 2 years. From 1859 to 1862 we find him engaged on the management of the oak and beech forests in the Vosges at the source of the Saône. In all these forests he originated working-plans of considerable importance, and thereby acquired the fullest knowledge of the requirements of the different species.

It was in the last named division that the skill of the practical young forest officer first came to the notice of Parade, the then Director of the French Forest School, who transferred him to Nancy, where he was appointed lecturer on forest working-plans, holding at the same time charge of the Forêt de Haye.

At Nancy Broilliard laboured fully 18 years. Notwithstanding the exacting duties of the professorship, he managed to find time to solve numerous special problems connected with forest management and to make himself acquainted with all the more important forests of France.

In 1881 he relinquished the Chair of Forest Working-Plans and was appointed conservator, first at Macon, and three years later at Dijon, which latter post he held until his retirement in 1891. During these 10 years he was enabled to put his theories into practice and also carried out most of his studies of the forests of foreign countries. From 1892 onwards his whole time was given up to the *Revue des Eaux et Forêts.*

Such briefly has been the life of Broilliard, but the work accomplished by his versatile genius cannot be described in so few words. His writings and teaching have established his reputation as one of the most distinguished masters of forest science, and he has long been the recognized head of the French School. Brilliant as he is as a theorist he proved himself no less efficient in outdoor work, and his pre-eminent qualifications marked him out for a ruling position. Broilliard unites rare talent with extraordinary knowledge. His thoroughly scientific education, constantly kept up to date by an attentive study of new forest literature, was supplemented by the great accumulation of knowledge he had acquired as a close observer of nature, by travel and by long experience as a practical worker. Few persons have been gifted with Broilliard's faculty of at once grasping the true facts and conditions and of forming a correct judgment in regard to them. With all his learning he was however by no means a mere theorist. His theories were formed not in the study but in the forest, and for this reason his teaching has always been welcomed by the practical worker, and his clear and terse writings, remarkable

not the less for the elegance of his language, bear the unmistakable stamp of originality and freshness.

His first work, and one which marked a distinct epoch in forest science, was the *Cours d'aménagement*, a summary of his lectures on working-plans, which appeared in 1878. This was shortly followed by *Le traitement des bois en France*, an important work written with special regard to the needs of the owners of private forests. Broilliard is further the author of the numerous articles in various forest periodicals, especially in the *Revue des Eaux et Forêts*, dealing with all the forest questions of the day, which have exercised a great and beneficial influence on the development of Forestry in France. To Broilliard belongs the credit of having been the first in France to recognize the necessity of treating and utilizing forests in accordance with the requirements of each separate standard and of subordinating to this all considerations in regard to continuity of yield and regularity of age classes. His writings in regard to the selection-and-coppice standard systems are among the most important published on these subjects. No one has advocated more strenuously and with greater success the raising of the felling rotation of coppice woods and the provision of an increased proportion of valuable oak timber as standards. But above all we have to thank him for the development of the French doctrine of regarding thinnings in the light of a gradual freeing the crowns of the principal individuals combined with the maintenance of an undergrowth for the purpose of protecting the soil. Few however have understood so fully as Broilliard the actual life of the forest, the claims of each individual species in it, and the high importance of even the least of these as a part of the whole.

Much more could be written in praise of Broilliard's work and yet leave much untold. May he in the evening of his life enjoy many happy days of well earned repose.

Chir (Pinus longifolia) "Twig-borer."

By B. O. Coventry, F.C.H.

During the hill tour with the Forest School students in Jaunsar, April 1901, Mr. F. Gleadow drew my attention to a malformity of the newly-formed shoots of the young chir pines in a forest between Khatian and Thadiar. The malformed shoots (usually leading shoots) were bent down, brown and dry, with a "fox-brush" like appearance. On examining them they were found to be hollow and full of dry resin and brown excreta of a lepidopterous larva; but no insect could be discovered. In 1902 the same conditions were observed, but again no insect could be found, and it was presumed that the season was evidently too late to catch the culprit at work.

This year, May 1903, whilst aligning a road, with the junior class students, at Koti Kanasar, our work took us down into the chir pine zone, and here again the same malformity of the new shoots on the young chir pines was observed. On this occasion however I was successful in finding the culprit, namely, a lepidopterous larva, as was at first suspected. The first larva was discovered underneath the bark of the stem of the previous year's growth and not in the current year's shoot. It appears that the larva, after having tunnelled down the current year's shoot, which gradually dries and bends over as the damage extends, comes outside and tunnels into an older stem, in which it tunnels up and down irregularly underneath the thin bark, feeding on the soft tissues between the bark and the hard central core of wood. In this latter position the larva is difficult to detect, as the stem is covered with long green needles, and shows no apparent signs of being attacked; but a closer observation will show that there are small openings on the surface of the bark from which resin and excreta have exuded. The larvæ however were not easy to find, for although I carefully searched a fairly large number of attacked plants, I only succeeded in finding half a dozen larvæ, three of which were in current year's shoots, which had only been partly destroyed, as in the case illustrated in the accompanying photograph,* the other three being in the older portion of the stem under the bark. The probabilities therefore are that the larvæ, when mature, leave the plant and pupate in the ground.

It appears probable that the eggs are laid on the terminal buds or young shoots, that the young larvæ live in the current year's shoots, first of all in those which are very young, then attacking those which are more advanced, and finally attacking the older stem; eventually, when mature, leaving the plant and pupating in the ground: a larva found on 14th May pupated on the 28th May and the moth emerged on the 22nd June.

The larva is, when full grown, about 1 inch long, bright pink in colour, with a brown head, smooth and shining, but becomes a dirty greenish colour just before pupating. It is thicker at the centre of the body, tapering to both extremities, and is furnished with a few short stiff hairs.

It is very sensitive when touched, wriggling away with great activity. The pupa is red-brown in colour, being paler on the ventral surface and with a dark line down the dorsal surface, the last segment being dark with a few bristle-like hairs. It is slightly over $\frac{1}{2}$ inch in length.

The moth measures $1\frac{1}{8}$ inch across the expanded wings. The fore wings are of a purple-grey colour with brown markings. The hind wings are hyaline with a brown tinge. Both fore and hind wings have a fringe of ciliæ.

* We regret to say that it has been found impossible to satisfactorily reproduce this photograph.

The moth appears to resemble, as far as I can judge, the description of *Phycita abietella* given on page 108 of Stebbing's No. 1 "Departmental Notes on Insects which affect Forestry." If it should turn out to be the same insect, the above will be an interesting addition to its life-history. The insect is being sent to Mr. Stebbing for identification.*

The accompanying photographs show a malformed shoot; which is partially destroyed. The upper portion marked *a* has been tunnelled down and has bent over and become dry and brown, the needles being malformed. The larva has tunnelled as far as the dotted line and is working downwards. After reaching the base *d* of the terminal shoot *a* it will probably come outside and tunnel into the previous year's shoot *e*.

I have not yet had sufficient opportunity of ascertaining the extent of the damage caused by this insect. The destruction of the leading shoot does not, as far as I have at present seen, lead to any permanent injury by causing the tree to fork, as is the case with the "Tun twig-borer". The destroyed leader becomes replaced by one of the shoots which would ordinarily have been a side branch. The destruction of the cambium and sapwood, in the older portion of the stem lower down, appears likely to result in serious damage by causing the whole of the plant above to die, but I have not yet been able to determine if this takes place or not, and it is to be hoped that those who have chir forests close at hand will try and obtain further information.

Cordite Rifles in Indian Forests.

In answer to "Big Game's" letter in your number for October, the following *pros* and *cons*, based on practical experience, will probably assist "Big Game" in coming to a conclusion on the questions he raises.

As "Big Game" mentions bison particularly and does not mention any other sort of game, I have confined my remarks to this particular species of heavy game.

Before proceeding to deal with the question of powders, bullets and rifles it is necessary to discuss briefly a few of the habits of the bison in order to determine what is required of a bullet in order to deal with a charging bison.

The cases on record in which an unwounded bison has charged are exceedingly rare; so much so, in fact, that the probabilities of a charge need not be taken into account. On the chance therefore of receiving a charge there is no necessity to continuously carry a heavy rifle during a stalk, and as will be afterwards shown, this is also unnecessary in order to bring the stalk to a successful finish. Turning now to wounded bison. A wounded bison will usually try to escape, but he will sometimes round and charge, and the possibilities of his doing so must be taken into account.

In the cases which have been recorded of a bison charging mention has seldom been made as to his mode of attack, and

whether he came on with his head up or down. In the single instance in which I have been charged by a bison, the bison held his head up until within a few feet of me; he then lowered it to strike, but as this is the only instance in which I have seen a bison charge, I cannot say whether this is their invariable mode of attack or not. However, it does not matter very materially whether they do or not. There is no exception to the rule however that a charging bison must be coming head on and either uphill, on level ground or downhill, and almost invariably from a short distance.

The shot at a charging bison is therefore a hurried one, and the only shots that will kill him outright are—

(1) a shot in the brain;

(2) a shot in the neck or back from above, so as to break his neck or back;

(3) A shot in the neck so as to break it from below. (A heart or chest shot will seldom stop a charging beast).

These are the shots that will kill him. Now any rifle that the sportsman is carrying after bison with a hard bullet will reach these spots, from a Mannlicher up to a ·577. The matter in the first instance is therefore chiefly a matter of aim, but other considerations must be taken into account.

Firstly, a smokeless powder in one barrel at least will leave the sportsman free to put in a second shot, whereas black powder will leave the sportsman in darkness for a few seconds; and I do not hold with the theory that the bang and smoke of black powder will turn an animal.

Now as regards the bullet; it is essential that the bullet must be of a penetrating nature, and this of course can be sufficiently well obtained in small and big rifles, but the chances of a big bullet touching one of the vital spots is greater, and even the mere fact of it passing close to the vital spot will suffice in some cases; whereas with a small bullet this is seldom the case. So much for the deadly shots at a charging bison. Of other shots which will save the sportsman there are two.

Firstly, a shot breaking the foreleg will bring the bison over, or at any rate so disable him that an active man who keeps his head can easily escape. Here again, however, the arguments given above as regards powder and bullets hold good.

Secondly, there is a shot which misses a deadly spot but gets him either in the chest, shoulder, neck or face, and a shot fired at a charging bison is as likely to hit one of these places as it is to break his neck, back or reach his brain. What I mean to say is, that it is very likely the deadly spot will be missed.

Now in this case again smokeless powder is preferable to black for the reasons already shown. But, on the other hand, a heavy bullet is absolutely essential, as the sportsman must either floor or turn the bison from sheer shock.

There are two ways of producing this shock. Either by a fairly large bullet, such as a ·450 driven at great velocity by a nitro powder, or a heavier bullet driven at a less velocity by black powder or a nitro powder; Sir Sam Baker states a bullet from the "Baby" catching an animal fairly never failed to stop it. The "Baby" was a 4 bore, and, speaking from memory, I think it weighed 22 lbs. and carried 16 drams of powder.

But since Sir Sam Baker's day rifles and powders have been greatly altered, so that high velocity without a blinding smoke can be obtained, and thus making the use of a second barrel possible.

Moreover, it is not every man who could shoot with the "Baby," and for these reasons a modern big game rifle has two barrels, neither of which can carry so heavy a ball as the single barrelled rifles of past generations. Now of modern rifles there are three sorts in use which will do the required work, namely, the 8-bore, the ·577 and cordite ·450 express, but the former, namely, the 8-bore, only shoots black powder, which has its drawbacks as already shown, and as in fact the 8-bore is no improvement on the old type of black powder rifles, it need not be taken into account. Personally, if I was charged by a bison I would prefer to have the "Baby" in my hands than a double 8-bore.

The question really resolves itself into the ·577 or ·450 cordite express—which?

The consideration of smoke does not apply, as the ·577 can be used with a smokeless powder, which gives as high a velocity as that obtained from black powder. The question is therefore narrowed to whether a ·450 bullet, driven 2,200 feet a second, or a ·577, driven at 1,600 feet a second, is best. This matter is one over which sportsmen differ greatly, and is one on which a verdict has still to be obtained. Probably there is not much to choose between the two, but as already shown above, there is a certain advantage in the heavier bullet, and as the penetration of the ·577 has proved itself sufficient, I consider the excessive penetration of the ·450 unnecessary. An illustration of how the energy produced by a bullet driven at a great velocity can be wasted is the following. Imagine a smaller bullet driven at 2,400 feet a second and a heavier bullet driven at 1,600 feet a second, and the weights of the two bullets so arranged that the striking energy is equal in both. Now imagine each bullet hitting a charging bison and catching him say in the shoulder. The smaller bullet would pass on

through the shoulder and into the body, and thus, as the striking energy of the bullet is distributed over the course it takes, some of the energy only is expended in the shoulder.

Now the larger bullet would penetrate and remain in the shoulder, thus expending all its energy in the one limb. It will be seen therefore that the striking force of the heavier bullet is more concentrated than that of the smaller, and this, in my opinion, is one of the reasons why the shock produced by the heavier bullet is the greater.

Personal experience has led me to prefer the heavier bullet to the smaller, even at the cost of a certain amount of velocity.

To recapitulate briefly the above remarks therefore: firstly, "BIG GAME" in following up wounded bison would do well to carry a rifle loaded with smokeless powder in at least one barrel.

Secondly, the rifle should be the heaviest "BIG GAME" can manipulate, by which I mean that the powder charge must give sufficient peneration, and after that the heavier the bullet the better.

I have now dealt fully with the question of wounded and charging bison, and I propose to conclude by adding a few remarks on rifles to use on unwounded bison, as in this case circumstances are altered, and the remarks which hold good for charging bison do not apply to unwounded bison. To begin with, in tracking up bison, although better, it is not necessary to continually carry a rifle in one's hand, as the bison can usually be heard before being seen, or at any rate unmistakable signs on the track show that the quarry is at hand. Rather therefore than tire oneself out, and this is likely to happen, as tracking bison is hard work, it is preferable to have the rifle carried and only take it on approaching. Now *one of the points about a shot at bison* is that it is nearly always a close shot. Many are shot under 50 yards and hardly any over 100; exceedingly accurate shooting is therefore possible.

Now the vital spots are the brain, neck, back; the neck and the back of course must be broken; then the heart and both lungs. It is necessary to wound both lungs; an animal will go a long way with one lung hit, whereas if both are penerated he will choke almost at once. To these I add the forelegs, as if a bison's foreleg be broken above the knee he will certainly be bagged; the shot however is not one that commends itself.

Now *firing at any of these spots, except the brain and leg, the* spots are more or less concealed, and in all instances, except the lungs the mark is a fairly small one. Accurate shooting is therefore necessary. It is of course an axiom in shooting, although one that is often forgotten, that the larger the game the more accurate the shooting must be in order to bag and not merely wound.

Personally, if I wish to make an accurate shot I prefer a small bore rifle, the Mauser for preference, and with this weapon at 50 yards I can make tolerably certain of hitting a 4-inch bull, whereas with a ·577 I am more likely to miss it than not. Of course there may be many men who have attained extreme accuracy with heavy rifles, but certainly the majority of men will shoot infinitely better with a small bore rifle. For the first shot under the following circumstances therefore I would advise "BIG GAME" to use the rifle which has sufficient penetration and with which he can make the most accurate shooting; if a large bore rifle of course so much the better.

The conditions in which this rifle is to be used are those which conduce to an accurate shot. These conditions are:—

1. The sportsman must be steady, by which I mean he must not be blown or excited.

2. The vital spot must clearly be seen.

(I take for granted the sportsman knows how to reach the vital spots.)

3. The bison must be standing quite still.

Under these circumstances a tolerable shot who does not get excited—but this frequently happens—will be almost certain of hitting a vital spot, and whether it is hit with a Mauser or a ·577 makes no difference. I should recommend him to fire either just at the base of the neck or for both lungs if this is possible.

Whenever the above conditions are not found, namely, if the sportsman is blown or is excited, or the bison is moving and it is impossible to be certain of hitting a vital spot, then accuracy and the small bore rifle must give place to the heavy rifle producing shock. In fact we return to the conditions already described under a charging bison, in which there is a probability of the vital spot being missed and the same arguments which applied in that case apply in this, and therefore the same rifle is recommended in this case as was recommended to meet a charging bison.

The above remarks are based on experience with bison in the Central Provinces only, to which part of India only they are meant to apply; in the main they probably hold good however for other parts as well.

SOLID LEAD.

Ripening of Cones of Pinus Longifolia.

I.

I HAVE read Mr. Birbal's letter several times but cannot understand exactly what he means. Apparently his meaning is (though I may be mistaken) that in the spring the young cones appear at the extremity of last year's shoot, and that the new shoot then grows out from below the young cones.

This seems to be a curious method of growth, and is quite different from what occurs here, which is as follows: Last year's shoot terminates in a bud. In March or April this bud expands and develops into a shoot, which bears at or near its extremity the young cones. When the shoot has expanded to its full length, it is found to be terminated by a bud, round which the young cones are situated. (The male cones are situated on and around the lower portion of the year's shoot and drop off soon after they have shed their pollen. (Male and female cones do not of course occur on the same shoot.)

Mr. Birbal does not attempt to prove his statement that the cones only take 12—15 months to ripen. If this is the case how does he explain the fact that in spring cones of three different years are found on the trees ? (I exclude the cones which have already shed their seed.) These cones are as follows: (1) the young cones at the extremity of the shoot ; (2) the half ripe cones at the base of the current year's shoot. These are still green and soft except the tips of the scales, which are brown and woody. (3) the large ripe cones at the base of last year's shoot. At this time of year (September) only two kinds of unripe cones are found on the trees, *viz.*, (*a*) this year's cones at the ends of the shoots and surrounding the terminal buds. These are now brown externally, but are green within. Next spring when they enlarge they will have the appearance of (2) above. (*b*) The cones at the base of the current year's shoot. These have nearly reached their full size, but are still green except the tips of the scales. They have become fairly hard. I have sent to the Forest School a branch which bears cones (*a*) and (*b*). All the Rangers in this district and some zamindars whom I have questioned state that the cones require two years to ripen.

Sirdar Bishen Singh, Extra-Assistant Conservator of Forests, has also proved the fact experimentally by attaching a piece of wire to the young cones.

Consequently there seems no doubt about the matter so far as the Punjab is concerned. It may be the case that at Dehra Dun the cones ripen in 12—15 months but it appears hardly likely.

E. B. COVENTRY,

Deputy Conservator of Forests.

II.

I see a letter in the last *Forester* from Birbal, Curator, with some queries about chil seed and its ripening. I enclose a copy of a table sent to me by yourself in 1886 showing the results of my observations made in that year, or rather printed in that year, for I began to make notes a year or so previous. I am quite sure of my facts, at any rate for the Chamba Valley.

J. C. MCDONELL.

TABLE SHOWING PERIODS OF RIPENING SEEDS OF CONIFERS IN THE HIMALAYAS.

Species.	First appearance of male flower.	First appearance of cone.	Pollen shower.	Cone scales closing.	Ripening of seed.	Time between first appearance of cone and falling of seed.	Remarks.
Cedrus Deodara, Deodar.	26th June	16th August	1st October	24th October	1st October	14 months	Male flower and young cone never found on the same tree. Cones erect. Empty cones non-persistent. Scales fall off separately when seed is ripe.
Abies Smithiana, Tos, Rai (Spruce)	15th April	20th April	4th May	14th May	November	7 months.	Empty cones persistent. Cone pendulous and falls complete, scales not detached.
Abies Webbiana, Rai, Morinda (Silver Fir).	15th April	20th April	4th May	14th May	November	7 months.	Cones erect and break to pieces when seed is ripe.
Pinus excelsa, Kail (Blue Pine).	16th April	26th April	3rd May	5th June	November	19 months.	The same tree may have (1) male flower, (2) young cone, (3) ripening cone, (4) empty cones persistent. Cone erect when young, pendulous when mature, and falls complete; scales not detached.
Pinus longifolia, Chil (Chir).	15th Feb.	25th Feb.	1st March	15th March	1st July	29 months.	Young cones not only found on same tree as male flower but even on same leaf-bud or stem. One tree may have 4 years' cones on it at one and the same time and also the male flower. Cones pendulous. Empty cones long persistent Scales not detached when falling. The dates vary with elevation. The above are for the higher elevations.

6th May 1886.

J. C. McD.

Jaunsar Working Plan.

As an old Jaunsari I have read with great interest Mr. Clutterbuck's working-plan for the Jaunsar Division, United Provinces. May it have every success and may the old division flourish and improve under its provisions.

There is one point in the plan which I should like to see more fully discussed. Para 122, on which the possibility is based, says: There are no data as to the percentage of trees which pass from one class to another. The following are estimated figures, but care has been taken to keep them low so as not to vitiate the result:—

95 per cent class I survive for 40 years.	75 per cent. class III become II.
80 per cent. class II become I.	60 per cent. class IV become III.
	$33\frac{1}{3}$ per cent. class V become IV.

Taking these as given, the following are calculated from them:—

60 per cent. class III become I.	45 per cent. class IV become II.
36 per cent. class IV ,, I.	20 per cent. class V become III.
12 per cent. class V ,, I.	15 per cent. class V ,, II.

It would be useful to know how these figures were estimated, as most of them seem to be too high. In these mountainous forests, with so much precipitous ground, such variable depth of soil and so many different aspects, it would seem that the ordinary formulæ of text-books need considerable adaptation before they can be safely employed. Is it not possible that, owing chiefly to the above causes, a much larger proportion of the different classes fail to reach the next class, within the average time, than is commonly supposed. Believing this to be the case, when I prepared a working-plan for the Naini Tal sub-division, in the portions where enumerations were made 15 years previously, a general fresh counting was not made, but the stock in four compartments was re-enumerated, the exact number of trees felled during the past 15 years being known. The result was as follows as regards Chir (*Pinus longifolia*), all decimal points below ·5 being omitted for simplicity's sake.

	Compartments.		
Percentage of II class chir entering I class in 15 years	9	9&10	7–10
Do. III do. do. II do.	11	10	11
Do. IV do. do. III do.	17	19	18
	15	22	20·5

The different countings thus give very similar results and point to the very fair accuracy of this method of estimating the stock. The only great difference is in the percentage of IV class

trees becoming III class ones, and this was only to be expected, it being but natural that the number of suppressed trees in the IV class should vary considerably with the density of the young pole forest. These countings show the actual changes which have taken place in the growth of nearly 10,000 chir trees stocking 370 acres.

Taking the percentages of trees passing from one class to the other as determined above for a period of 32 years, the average time it takes in Naini Tal (according to ring-counting) for a IV class tree of the lowest dimension to reach the III class :—

43	per cent. of	II	class chir becomes	I	within	the average time.
56	do.	III	do.	II	do.	do.
25	do.	III	do.	I	do.	do.

Might I venture to suggest that half-a-dozen carefully selected compartments at different aspects, etc., which were enumerated in 1888, and where the number of trees felled since is accurately known, be re-enumerated. We should then be in a position to judge whether the figures adopted in para. 122 are sufficiently near the mark or not.

N. HEARLE.

III.—OFFICIAL PAPERS AND INTELLIGENCE.

Mr. F. B. Dickinson.

IT is with the greatest regret that we have received news of the death of Mr. F. B. Dickinson, Conservator of Forests, Central Circle, U. P., at Almora on the 12th October, at the comparatively early age of 52.

Mr. Dickinson received his professional training at Nancy, coming out to India in 1872, and has, since the death of Mr. Hill, been the sole representative of his year in the Bengal Presidency. On his arrival in India he was posted to the C. P., and after gaining an intimate knowledge of the forests of those provinces and of Berar and Coorg, he was confirmed as Conservator in Burma in 1894.

His health gave way completely under the malign influences of the Burma climate, and although he went on long furlough to recruit, he never entirely recovered. On his return from furlough in 1899 he was appointed to the charge of the Central Circle, U. P., where he remained until his death.

There was, we venture to think, no one in the Department more universally and deservedly popular: it is difficult to believe that he had a single enemy, while his unfailing courtesy, cheeriness and good nature gained for him hosts of friends wherever he went. As a forest officer his loss is unquestionable, and it will be difficult to replace him, as his long and varied experience, combined with ripe judgment and tact, rendered his services specially valuable.

His many personal friends, as well as those who have been brought into contact with him in their official capacity, will mourn his premature death, which adds another name to the long roll of Englishmen who, by sacrificing their health to their high sense of duty in the fever laden portions of the Empire, have worthily upheld the traditions of their race.

Mr. Dickinson's death is all the more sad as he contemplated quitting the country for good within the next 18 months.

The Preservation, Seasoning and Strengthening of Timber.

MR. W. POWELL read a paper on this subject before the Engineering Section of the British Association at Southport on Wednesday (September 16th, 1903). He said that he proposed to show how some kinds of timber at present valueless might become

exceedingly useful; how timber used for structural purposes might be so strengthened as to bear a much greater load or strain; how our streets might be cheaply paved with sanitary wood blocks which would neither absorb surface water nor give out disagreeable effluvia; how the ravages of dry rot might be combated; and how all this might be done simply and at comparatively small cost. Seasoning timber, either by natural or artificial means, tended to impair its strength by reducing its specific gravity, and this was especially the case in timber rapidly dried by artificial means. He had found that by boiling timber in a thin saccharine solution until most of the air in the timber was exhausted, and then by leaving the wood in the syrup to cool, a certain amount of the sugar was absorbed by the timber, in some cases so much as to cause the timber to sink. After the wood had become sufficiently saturated it was put into a drying stove and the moisture driven off at a fairly high temperature until the wood was thoroughly dryseasoned, as the term goes, and it was then ready for immediate use. This process differed from others mainly in the fact that before drying was attempted the interstices of the timber were filled in with a viscid, glutinous solution, which took the place of the natural sap and air which the wood had been forced to part with. So, when the moisture was driven off by stoving, the sugat which remained in the wood acted like a strong binder, and held the fibres together, just as cement or mortar bound the stones or bricks in a wall. He was informed by Dr. Herman von Schrenk, the head of the Forest Products Branch of the United States Forestry Department, that there were thousands of square miles of land in the States covered with timber which at present was of little or no commercial value; and the same might also be said of Canada and most other timber-producing countries. These useless trees might aptly be called the weeds of the timber garden. Most of them were too weak, too sappy, too porous, and were so liable to rapid decay as to be not worth cutting down. In some respects they were similar to our English poplar, and, like it, grew very quickly. This class of timber was especially amenable to the process he had described, and the results were somewhat astounding. Poplar absorbed over two and a half times its own weight of the solution, and when thoroughly dried was 75 per cent. heavier than in its natural state. If this could be effected with our English poplar there was every reason to believe the same results might be obtained with the soft woods of America and other countries, and so a fresh source of supply of timber most suitable for railway sleepers, paving blocks, planks for piers, stations, etc., might be opened up. Everyone was aware of the power of wood pavements to emit stifling effluvia, especially on a hot, close summer night. The excreta absorbed by the block, and thus evaporated, made it a perpetual source not only of discomfort, but possibly of ill-health. If the good qualities of soft wood could be retained, while making it not only harder

and tougher, but, above all, less absorbent, then one of the great difficulties of the municipal engineer would have been solved. While the weight of pine was not much increased by the process, its effects on the strength of the wood was remarkable. Experiments showed that the tensile strength of pitch pine was increased from 14 to 32 per cent., of white pine from 29 to 39 per cent., of yellow pine from 56 to 107 per cent. Tests as to the effect of the process on the flammability of wood, especially of such wood as the pines, showed that it was to make the wood less inflammable, by reason of its greater compactness and solidity. Beech came next to poplar in its greediness for syrup, and its weight was increased by treatment by about 50 per cent. It became a very firm, tough timber, nearly as tough as oak or teak, without having their brittleness. As to the cost of the process, sugar was a very cheap raw material, being only about the same price, weight for weight, as the lower-priced woods, and if the by-products of sugar manufacture were used the cost would be almost nominal. The amount of labour involved in the process is comparatively small, and the plant was simple.—*Timber Trades Journal.*

THE RELATIONS OF FORESTRY TO ZOOLOGY.—It has been pointed out recently by H. A. Surface, professor of Zoology at Pennsylvania State College, that there is a direct and important connection between forestry and zoology, and he gives several examples of how this connection exists. Aside from the clearing of forest growths, which naturally drives the denizens of the woods from the cleared localities, he finds that the effect of forest destruction on streams is a far-reaching one. Clear streams, flowing perpetually through wooded country, are the natural haunt of the trout: but if the country in which these streams rise or have their courses is destructively cut over, the streams themselves become intermittent, muddy, and in some cases only a succession of warm and slime-covered pools in midsummer. As such they are fit only for the lurking places of the mud-sucker and the carp. In the larger streams and rivers, which, under natural conditions, are the homes of the desirable game fishes, the black bass and pickerel, which pass the winter in deep pools in a state of partial hibernation or quietude, the changes are even more to be deplored when the watershed is deforested. Floods arising from the destruction of the trees bring down immense quantities of silt, "washings," sand, etc., and deposit them in the deep pools where the current runs slower, so that the quiescent fish are covered over and destroyed. Another disastrous result comes from the washing of the fishes out of their places of winter abode, dashing them against rocks and ice and in some cases leaving them stranded to gasp out their lives after the water subsides.

The setting aside of forest reserves will not only keep the forest and the beauty of the landscape, but will restore game and

song birds to their original haunts, protect the wild animals, and preserve the most desirable fishes—the trout, bass, and pickerel.

[We have often pointed out the desirability of protecting and encouraging insectivorous birds in this country. Copses and hedgerows are essential to such for nesting purposes, and both the forester and agriculturist should bear this in mind. From a scientific point of view it is equally desirable to protect animals, and more especially those species whom contact with man tends to decimate and reduce to extinction. The formation of large closed reserves is the one practical remedy to safeguard them from much to be deplored extinction.—HON. ED.]

FORESTRY IN SARAWAK.—The country of Sarawak, Island of Borneo, is best known to the rest of the world through the exploits of the first Rajah Brooke, an Englishman who, unaided and alone, took a Malayan province in the throes of internal war, and by his force and foresight made an independent nation of it, and giving at the same time the best example of European government of Asiatics. The present Rajah, nephew of the great Rajah Brooke, is following the policy of his predecessor in taking an interest in everything that concerns the welfare of his people, from the most trivial to the most serious. Among other things, *he has taken an interest in forest preservation*, as explained in the subjoined report reprinted from the *Outlook*:—

"A meeting of the council was convened this day. His Highness the Rajah informed the members he had what he considered an important matter to lay before them in reference to the future supply of timber for building purposes. At present large quantities of different kinds of woods are being felled immediately in the vicinity of the principal town, for export; and a trade had sprung up which threatened to despoil the forests of all the best and most useful woods necessary to the inhabitants of a growing town. At this end of the state, where so much wood is now being worked for export, the country is comparatively narrow, being only a few miles in depth to the boundary with Netherlands territory; and in this narrow strip of land large quantities of valuable timber have been destroyed by generations of Dyak farming. What there is left should be preserved as far as possible for local use, for were these woods, even the commonest of them, once worked out, the inhabitants of this town and the neighbourhood would be put to the greatest inconvenience.

"His Highness now proposed that all woods in the forests *lying between Tanjong Datu and the right bank of the Sadong* River shall be preserved for the use of the inhabitants, and that after six months from the present date the exportation of timber from any port within the above-mentioned limits shall be prohibited.

"This was carried unanimously."

Dr. Schlich, F.R.S., and Forestry at Ci'cester.—In connection with the note upon this subject in the September number of the Magazine, Dr. Schlich has asked us to point out that the appointment of Honorary Professor in the Forestry Chair at the College does not necessitate his taking up residence there or entail the delivering of lectures. He will act as adviser on Forestry matters and perhaps deliver an annual address.

Eucalypts for Fuel.—Californians are devoting considerable attention to the growing of Eucalyptus trees for fuel purposes. The remarkably rapid growth makes certain species specially adapted for firewood. Their advantages are, besides maturing quickly, ability to thrive in thick stands and to reproduce abundant timber in coppice growth. Near El Toro, California, 3,600 acres will be planted with this exotic, for fuel purposes alone. Experiments demonstrate that under favourable conditions 20 tons of dry wood a year may be perennially cut from well-managed groves at a cost much less than that of coal.

Proposed School of Forestry for Wales.—At the quarterly meeting of the Pembrokeshire County Council, held in the Shire Hall, Haverfordwest, on Tuesday, August 4th, Dr. Griffiths in the chair, it was proposed and seconded that the following councillors represent that Council at the conference of the whole of the County Councils in the Principality, and that the place of meeting be the Shire Hall, Haverfordwest, in October next:—Sir Charles Phillips, Bart., Messrs. W. H. Waters, Edward Robinson, and E. Egerton Allen. The Clerk was also instructed to notify the fact to the respective County Councils.

Jarrah Sleepers.—The growing popularity of jarrah sleepers on Indian railways is indicated by an order just placed with the Bengal-Nagpur Railway for 30,000. The East Indian Railway are ordering the new timber in lakhs, and we hear the Calcutta Port Commissioners are contemplating a large purchase for their lines. This last mentioned conversion to the new cult is probably due to the fact that the present Port Trust Engineers are old railway men. The E. B. S. R. are showing signs of conversion also to the adoption of the Australian timber.

Japanese Wood Pulp Trade.—The Japanese wood pulp trade, which has only figured in the Customs returns since 1898, is, according to H. M. Consul at Yokohama, growing largely, with the result that the demand may advance for some years yet, but the material is in the country, and only proper methods of working and transport are needed to obtain a local supply. As an instance it may be mentioned that one company near the

capital, which as recently as 1900 imported from abroad, has now set up a mill in the wooded districts and manufactures its own pulp, both chemical and mechanical. The chief foreign supplies come from Germany and Norway. Canada only supplied 313 tons in 1902—figures which should be capable of great expansion if attention was given to the matter.